CITY OF FRESNO

FRESNO-CLOVIS REGIONAL WASTEWATER
RECLAMATION FACILITIES MASTER PLAN
TECHNICAL MEMORANDA EXCERPTS

DESCRIPTION OF EXISTING FACILITIES
EVALUATION OF REGIONAL TREATMENT PLANT EXPANSION
AND CAPACITY OF EXISTING FACILITIES

carollo engineers

Fresno-Clovis Regional
Wastewater Reclamation Facilities

MASTER PLAN REPORT

TASK 200
TECHNICAL MEMORANDUM NO. 1

DESCRIPTION OF EXISTING FACILITIES

July 1996

W:\4030A00\200TM1.COV

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES
MASTER PLAN REPORT

TASK 200
TECHNICAL MEMORANDUM NO. 1
DESCRIPTION OF EXISTING FACILITIES

TABLE OF CONTENTS

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES
MASTER PLAN REPORT

TASK 200
TECHNICAL MEMORANDUM NO. 1
DESCRIPTION OF EXISTING FACILITIES

TABLE OF CONTENTS
(Continued)

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES
MASTER PLAN REPORT

TASK 200
TECHNICAL MEMORANDUM NO. 1
DESCRIPTION OF EXISTING FACILITIES

LIST OF TABLES

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES MASTER PLAN REPORT

TASK 200
TECHNICAL MEMORANDUM NO. 1
DESCRIPTION OF EXISTING FACILITIES

LIST OF FIGURES

DESCRIPTION OF EXISTING FACILITIES

INTRODUCTION

The purpose of this technical memorandum (TM) is to provide a brief overview of the treatment and disposal facilities at the Fresno-Clovis Regional Wastewater Reclamation Facilities (RWRF). The historical performance of the facilities is discussed in Task 200 TM 2.

Nomenclature

The nomenclature used to define the previous, current, and future RWRF facilities is summarized below. Facilities are defined according to the RWRF's design capacity at average dry weather flow (ADWF).

Existing Facilities

All facilities that bring the design capacity of the RWRF to 80 million gallons per day (mgd). The facilities represent the completion of the Phase 1A and Phase 1B expansion projects described below. A process flow schematic of the existing facilities is provided in Figure 1.

The 80 mgd capacity refers to Plant No. 1 only (Plant No. 2 may be decommissioned following this expansion project, or maintained to supplement the capacity to Plant No. 1 when needed).

Phase 1A Expansion

The Plant No. 1 facilities completed in 1996 for the first phase of the 80 mgd expansion. The expansion brought the total RWRF capacity to 68 mgd (includes both Plant No. 1 [62 mgd] and No. 2 [6 mgd]).

Phase 1B Expansion

The current expansion project that will bring the total Plant No. 1 capacity to 80 mgd. Construction is scheduled to begin in late 1996-early 1997, and the facilities are anticipated to be on-line by late 1998 or early 1999.

Phase 2A Expansion

The future facilities anticipated to be completed in the year 2001. The facilities are developed in this Master Plan, and are summarized in Task 600 TM 3 and Task 1100 TM 1.

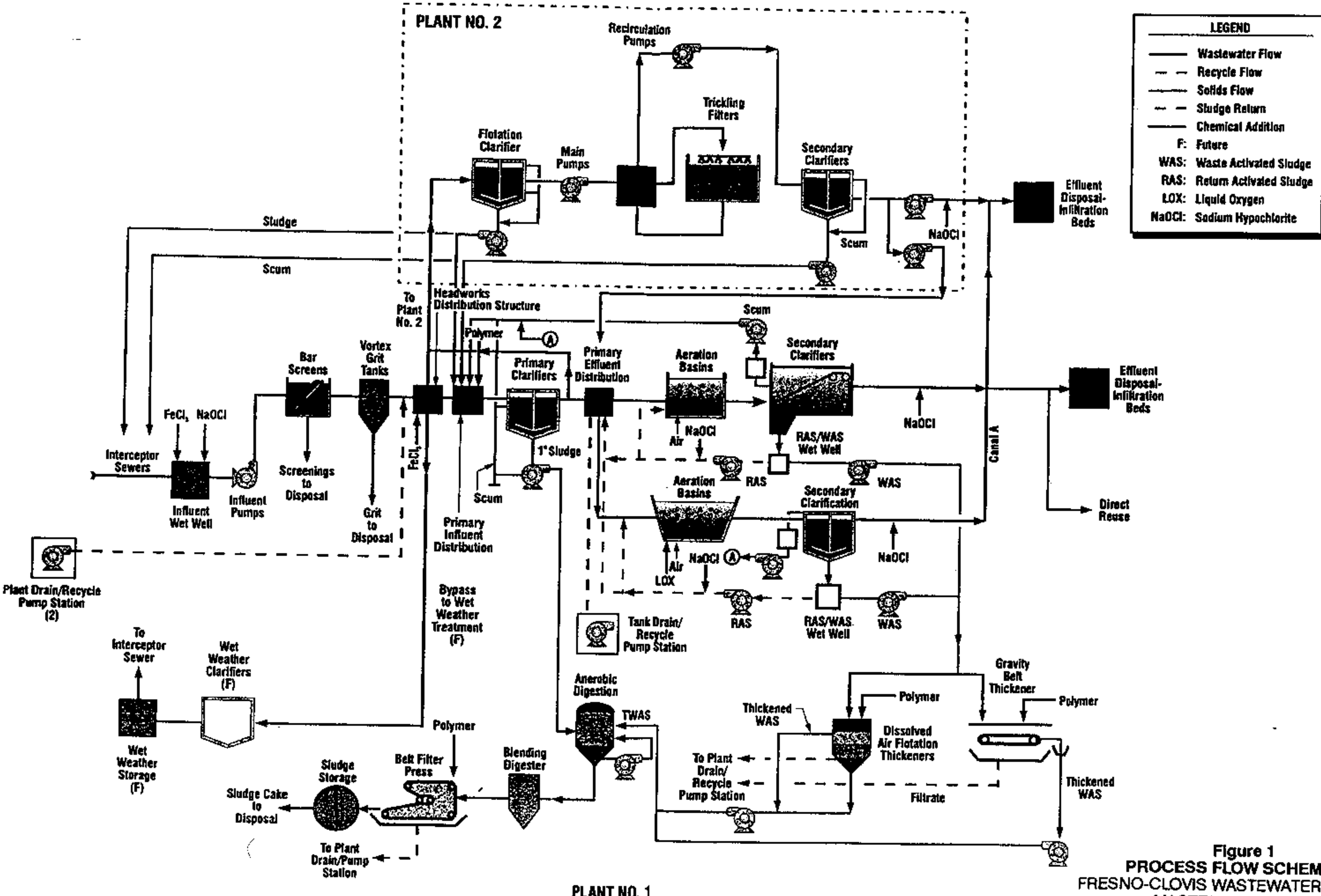


Figure 1
PROCESS FLOW SCHEMATIC
FRESNO-CLOVIS WASTEWATER FACILITIES
MASTER PLAN REPORT

Future Expansions

Any facilities beyond the Phase 2A expansion that will be needed to meet future needs through the year 2020. The facilities will be developed in this Master Plan and summarized in Task 600 TM 3.

Original Facilities

Refers to the Plant No. 1 and No. 2 facilities on-line prior to the Phase 1A expansion (capacity = 48 and 6 mgd, respectively).

RWRF

Refers to the overall treatment and disposal facilities as they are (or will be) permitted to operate. Currently, the RWRF currently includes both Plant Nos. 1 and 2, onsite effluent disposal facilities, sludge drying beds, and the winery stillage area.

Brief History of RWRF

The City of Fresno's sewerage system originated in 1891, and until 1907 all of the wastewater was disposed of on a 40-acre tract about one mile to the east of the RWRF's present site. In 1907, 812 acres were acquired at the present site and utilized for wastewater disposal through ground infiltration, a practice that continues today. At that same time, municipal septic tanks were installed to afford some degree of treatment, and additional tanks were added in 1917.

In 1947, a primary treatment plant (Plant No. 1) was constructed with a capacity of about 20 mgd. The plant consisted of two primary clarifiers, four sludge digesters, and an operations building. This plant was enlarged in 1952 with the construction of another clarifier and digester. In 1957, a fourth clarifier was added, and the total capacity for primary treatment became 37 mgd.

In 1960, a separate plant, Plant No. 2, was constructed approximately 4,000 feet south of the original Plant No. 1 site, and supplied by a new 66 inch diameter interceptor constructed along North Avenue. The 1960 construction involved headworks and a pumping plant. In 1962, two vacuators, two filters, and two clarifiers were added to provide partial secondary treatment. The capacity of Plant No. 2 was originally rated at 15 mgd.

The wastewater treatment facilities and ponding area have been enlarged gradually over the years, and now encompass 2,000 acres. In addition, approximately 2,890 acres of private farm land in the area are irrigated with treated effluent from the two plants.

During 1972, additional construction was completed at both plants; the intent was to provide a more efficient use of all existing facilities, not to increase flow capacity. Included in the project were: new headworks, two sludge thickeners, and enlargement of the existing operations building at Plant No. 1; a new scum line between Plant No. 1 and Plant No. 2; a distribution pumping plant and pipeline to convey treated wastewater from Plant No. 2 to Plant No. 1; a small experimental oxidation ponding system near Plant No. 2; and miscellaneous pumping and other facility improvements at both treatment plants.

Commencing in 1974, major construction was undertaken at both plants to bring the treatment capabilities up to secondary treatment standards, which would allow more stringent waste discharge requirements to be met. While a vast number of improvements were made at both plants, the major emphasis of the project were: to install complete secondary treatment facilities at Plant No. 1 to further treat the primary effluent from Plant Nos. 1 and 2; to develop infiltration and water reclamation systems for handling of the final effluent; to provide facilities for groundwater extraction and level control; and; to provide a separate system for the treatment and disposal of winery stillage wastes.

Two waste activated sludge (WAS) dissolved air flotation thickeners (DAFTs) were constructed at plant No. 1 in 1986. These were built to replace a high maintenance WAS centrifuge thickening system installed in the 1976 improvements.

In 1989, an upgrade to the Plant No. 1 aeration system was completed. This project added a fine bubble diffuser aeration system and 3 multistage centrifugal aeration blowers. The system replaced the original sparged turbine aeration equipment which had high operating cost and low oxygen transfer efficiency.

A Master Plan report was prepared in 1989 and recommended several improvements to the wastewater treatment facilities of Plants No. 1 and No. 2 (Ref. 1). Based on the recommendations of this report, facility improvements were designed in 1990 - 1992.

In 1993, several interim improvements were made to Plant No. 2, including:

1. Flotation Clarifier improvements including rerouting the effluent to the Trickling Filter.

2. Trickling filter recirculation pump station improvements.

3. Miscellaneous control and utility improvements.

The improvements are described in Task 600 TM 3. Physical characteristics and design criteria are summarized in Appendix B.

In 1991, preliminary design for an 80 mgd expansion and a phased expansion plan was developed (Ref. 2). Construction of the Phase 1A project was started in 1994 and was identified as the 68 mgd Expansion and Modernization Project for Plant No. 1. The purpose of this project was to expand the overall treatment system capacity of the RWRF to 68 mgd, and to modernize a number of facilities at Plant No. 1. Major facilities included in this expansion were:

1. New headworks, including influent pumping, screening, grit removal and flow distribution.

2. Four primary clarifiers and primary sludge pump station.

3. Two activated sludge basins and one blower facility.

4. Five secondary clarifiers and one RAS pump station.

5. Two new digesters and associated systems.

6. Distributed control system.

7. Miscellaneous utility and support systems.

Completion of the existing facilities (Phase 1B expansion project) will increase the total treatment capacity to 80 mgd at Plant No. 1. Two primary clarifiers, two aeration basins, four secondary clarifiers and two digesters will be added. These facilities will be on-line sometime in late 1998 or early 1999.

Waste Discharge Requirements

The RWRF operates under a Waste Discharge Requirements Order from the California Regional Water Quality Control Board, Central Valley Region (RWQCB). Discharge and regulatory requirements are described in detail in Task 500, TM 1. A Copy of the current RWQCB Order is included in Appendix A. Table 1 outlines the major effluent requirements for the facility.

RWRF LOCATION AND FACILITIES LAYOUT

Service Area

The RWRF treats domestic, commercial and industrial wastewater from the Fresno-Clovis Metropolitan Area (FCMA) including the municipalities of Fresno, Clovis, the Pinedale Water District and Pinedale Utilities District. A overall service area map is presented in Figure 2, and includes nearly all of Fresno-Clovis Metropolitan Area except for individual on-site systems and the small Malaga Water District system.

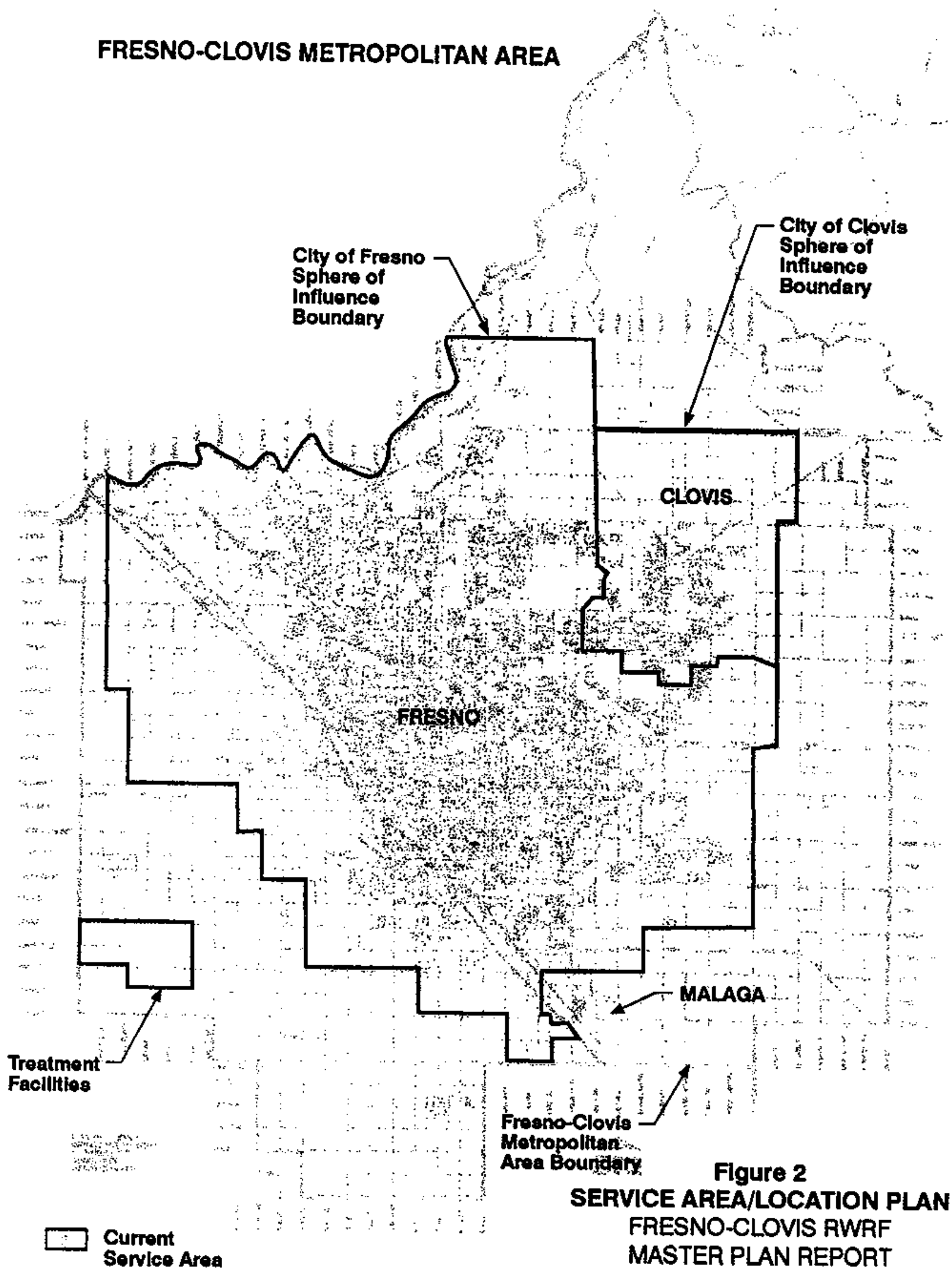


Figure 2
SERVICE AREA/LOCATION PLAN
FRESNO-CLOVIS RWRF
MASTER PLAN REPORT
TASK 200 TM #1

Table 1 **Waste Discharge Requirements** Fresno-Clovis Wastewater Master Plan				
Constituent	Units	Monthly Average	Daily Maximum	Sampling[1]
Flow[2]	mgd	62+6[3]	---	Cont
BOD_5	mg/L	40	80	Comp
TSS	mg/L	40	80	Comp
Settleable Matter	ml/L	0.2	0.5	Grab
Chlorides	mg/L	175	250	Grab
EC	µmhos/cm	900		Grab
pH	pH Units		6.0<pH<9.0	Grab

(1) Comp = Daily composíte.
Grab = Daily grab.
Cont = Continuous.
(2) Based on a monthly average dry weather flow (May through October)
(3) Plants No. 1 and No. 2, respectively.

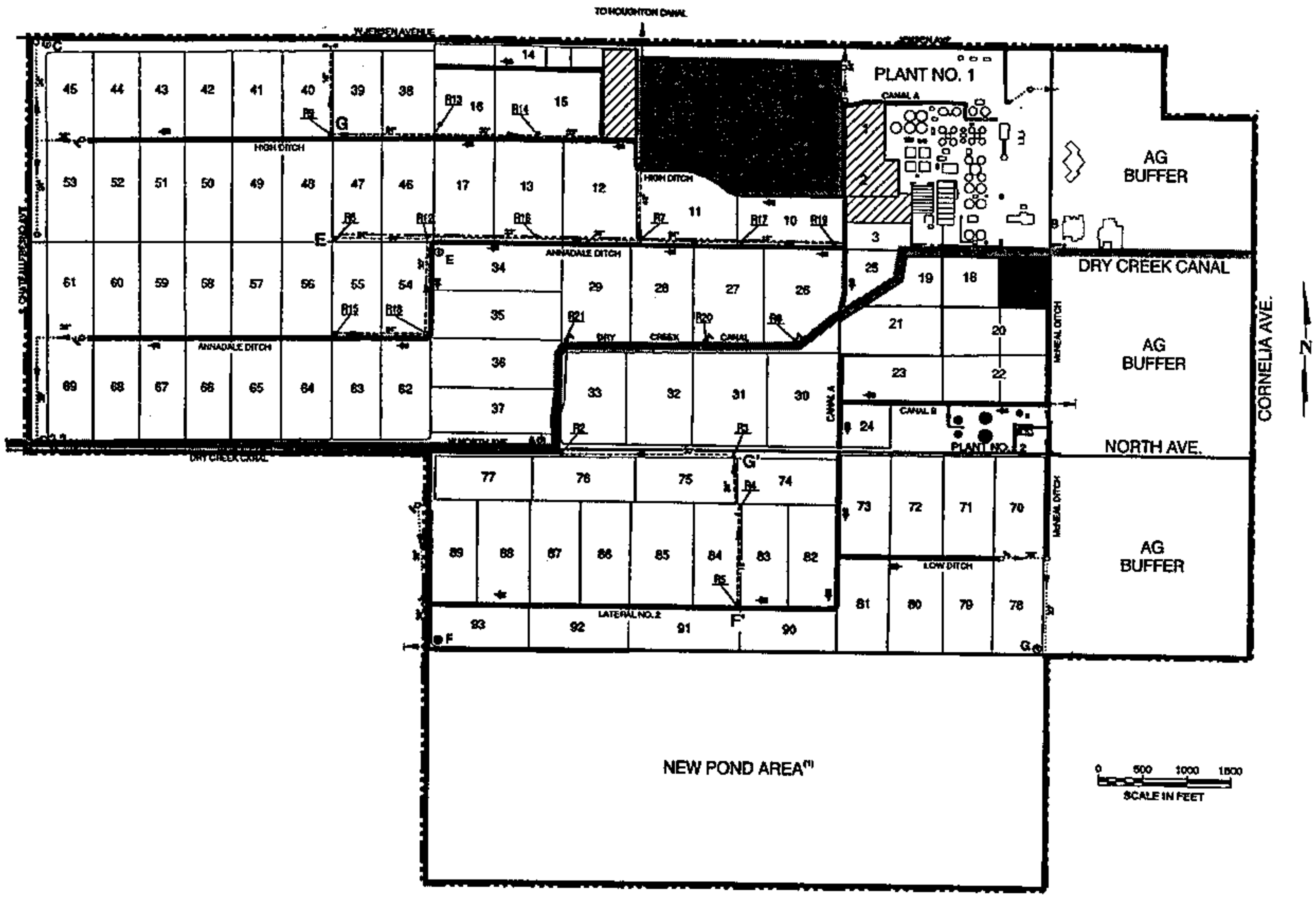
The sewage collection system serves approximately 500,000 residents. The industrial component of the wastewater flow has been estimated as approximately 11 percent of the total flow (see Task 200 TM 2). Three main interceptor sewers transport the raw sewage to the plant. The Fresno-Clovis area has relatively flat terrain, resulting in fairly flat interceptor lines.

Location

The RWRF is located approximately 6 miles southwest of downtown Fresno as shown on Figure 2. The facilities consist of two treatment plants (Plants Nos. 1 and 2), on-site effluent disposal facilities and a winery stillage disposal area. The site, including disposal ponds, covers over 2,000 acres. An overall treatment and disposal facility layout is shown on Figure 3. The two treatment plants are on the north-east side of the site, located closest to the influent interceptors that transport the sewage from the FCMA. The area is surrounded primarily by agricultural land with few residences located adjacent to the facility. An access road, extending from Jensen Avenue to North Avenue along the eastern side of the RWRF, provides controlled access to all existing facilities.

Interceptor Sewers

Three interceptor sewers transport raw sewage from the FCMA to the plants. The 84 inch Herndon-Cornelia interceptor runs south along Herndon-Cornelia Avenue and enters Plant No. 1 from the north. The 60 inch Jensen interceptor runs parallel to Jensen Avenue and ties into the



LEGEND

- 57— EFFLUENT POND DESIGNATION
- DISTRIBUTION CANAL
- R6 RECLAMATION WELL DESIGNATION
- • RECLAMATION WELL
- RECLAMATION PIPELINE
- IRRIGATION PIPELINE
- (1) To be constructed by mid 1997
- WINERY STILLAGE
- SLUDGE STORAGE/DRYING BEDS
- CONSTRUCTION FACILITIES
- RWRF PROPERTY BOUNDARY

Figure 3
EXISTING LAND USE AND FACILITIES
Fresno-Clovis Wastewater Facilities Master Plan Report

Herndon-Cornelia interceptor prior to entering the plant. The 66 inch North Avenue interceptor enters the site from the east along North avenue and then turns north toward the Plant No. 1 headworks. The capacity of these and potential future interceptors sewers is listed in Appendix B.

Plant No. 1 Layout

The layout for Plant No. 1 is shown in Figure 4. The activated sludge plant includes the following treatment facilities: preliminary, primary, and secondary unit processes; secondary effluent distribution system; solids handling facilities; septage receiving station, and; administrative and laboratory buildings. The following future buildings are also presented in Figure 4: the new administration/laboratory complex (scheduled to begin construction in 1998) and the maintenance building and warehouse, (both scheduled to begin construction in 1997).

The RWRF is bordered on the north by Jensen Avenue and to the west by South Chauteau Avenue. An existing road, West North Avenue, runs east and west through the center of the site. A Fresno Irrigation District (FID) canal, Dry Creek, also crosses the site from east to west.

Plant No. 2 Layout

The layout for Plant No. 2 is presented in Figure 5. Plant No. 2 is bordered on the south by North Avenue and to the east by the plant access road. The effluent disposal system borders the plant on the west and north. Either raw sewage or primary effluent can be delivered from Plant No. 1 for treatment at Plant No. 2. The plant effluent may be discharged directly to the effluent canal system or can be pumped to Plant No.1 for further treatment.

Effluent Disposal and Reclamation System Layout

The effluent disposal system consists of a canal distribution system infiltration beds and water reclamation pipelines and wells. The effluent disposal facilities are presented on Figure 2. These facilities were built in 1978 and remain essentially unimproved from the original design. The canal capacity is estimated to be approximately 110 mgd assuming a freeboard in the canal of six inches.

Treated effluent from the treatment process area is conveyed in canals that have been designated as Canal A, Canal B, High Ditch, Annadale Ditch, Low Ditch and Lateral No.2. Treated secondary effluent from Plant No. 1 is discharged to Canal A adjacent to the secondary clarifiers, or to an extension of High Ditch. The effluent is distributed from Canal A and High Ditch throughout the canal system to the infiltration beds. Plant No. 2 treated secondary effluent can either be pumped to Canal B for distribution to the infiltration beds, or to Plant No. 1 for further treatment.

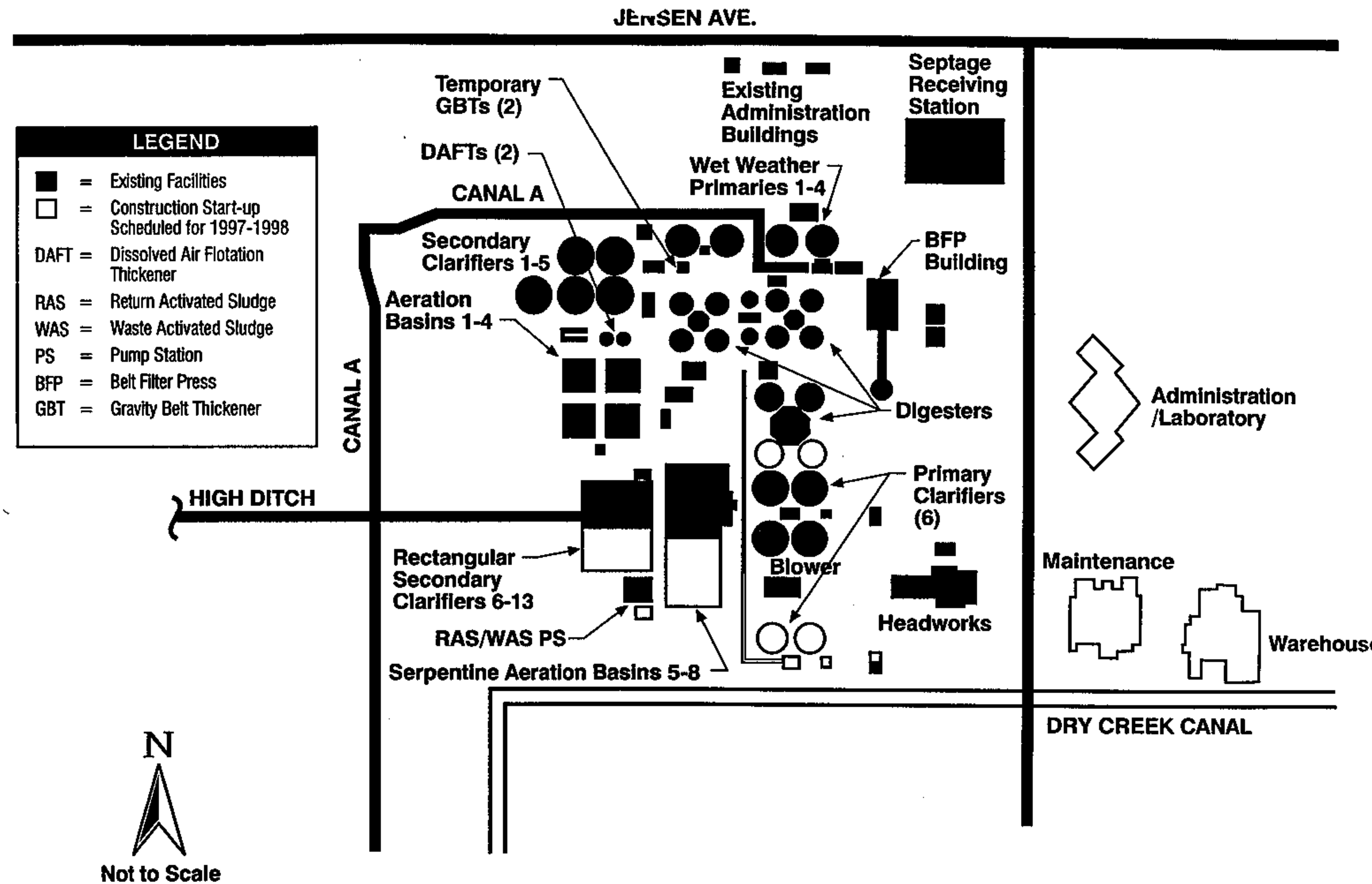


Figure 4
PLANT NO. 1 FACILITIES LAYOUT
FRESNO-CLOVIS WASTEWATER FACILITES
MASTER PLAN REPORT

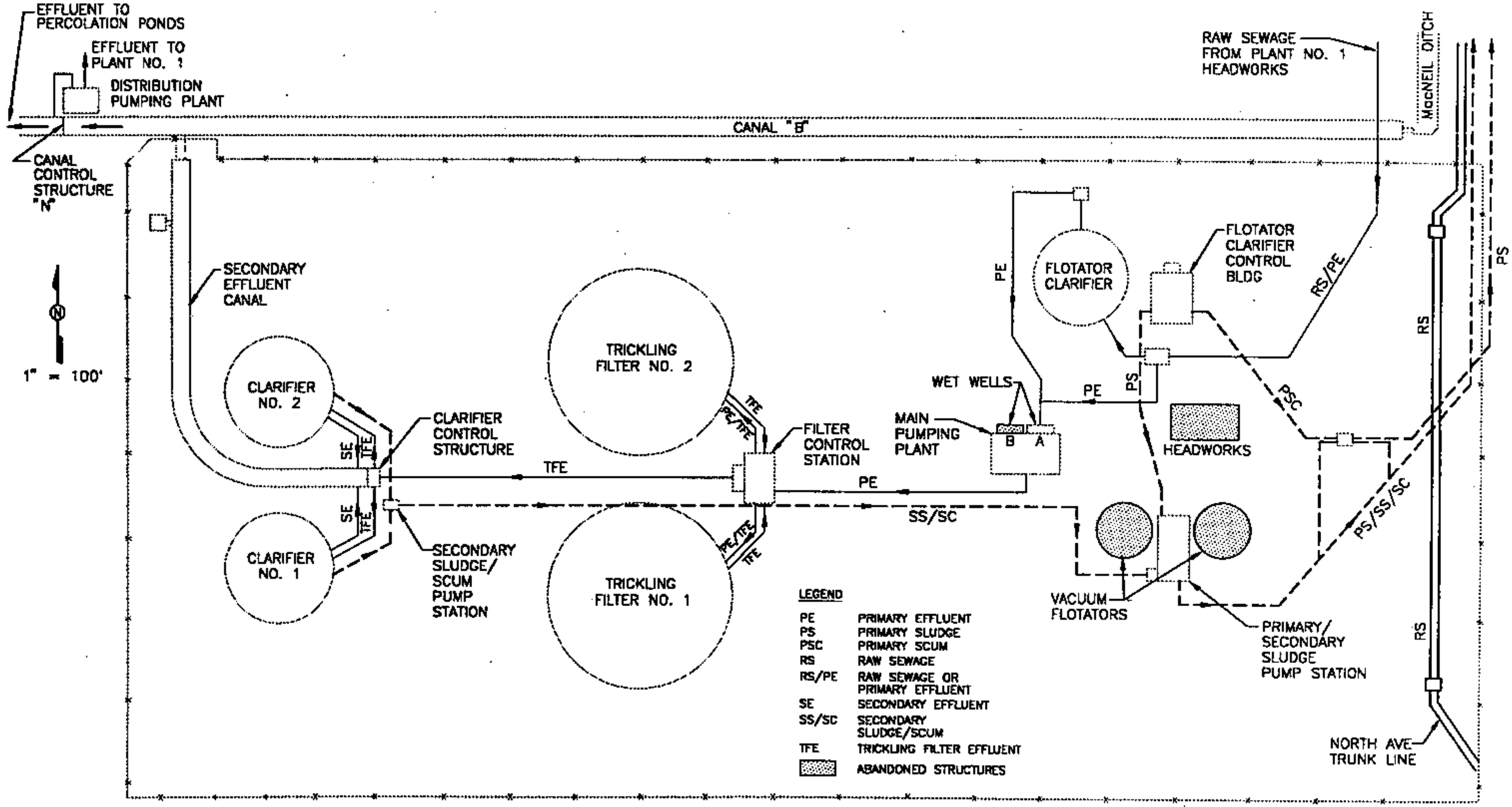


Figure 5
PLANT NO. 2 LAYOUT
Fresno-Clovis Wastewater Facilities
Master Plan Report

The existing infiltration beds cover an area of approximately 1,650 acres and have a net infiltration area of about 1,414 acres (less roadways and canals). The beds are rectangular in size and range from about 8 acres to almost 30 acres. Additions to the pond system are currently being built, and include approximately 320 acres (272 acres net). The interim and long term improvements for the effluent disposal including conveyance canals or pipelines and infiltration beds are presented in Task 600 TM 2.

LIQUID STREAM TREATMENT

The existing RWRF liquid stream treatment system (80 mgd) is described in this section. Treatment consists of preliminary, primary and two conventional air activated secondary treatment systems with a common headworks and a combined effluent disposal system. A simplified process schematic for this system is shown on Figure 1. Plant No. 2 may be decommissioned after the Phase 1B expansion project is complete, in 1998 - 1999 (see Task 600 TM 3).

Headworks and Preliminary Treatment

The physical characteristics of the headworks and preliminary treatment units are outlined in Appendix B. These units are briefly described below.

Flow Measurement

The influent flow from the two interceptor sewers (Herndon-Cornelia and North Avenue) flow through individual Parshall flumes. The flows then combine into a common distribution channel that splits the flow into either or both of the headwork's two wet wells. The flow to each wet well is controlled by four hydraulically operated gates.

Two wet wells are provided to allow for inspection or cleaning. The wet wells may be dewatered using grinder type horizontal dewatering pumps. Each wet well has its own pump for dewatering and scum removal.

Provisions for a total of six interceptor sewer connections, each with its own Parshall flume, have been provided. The capacities of the existing and future interceptors are listed in Appendix B.

Influent Pumps

Raw sewage is lifted from the wet well to the bar screen channel using six dry pit submersible pumps. The pumps are non-clog, vertical, bottom suction type and discharge to a common channel. Two pumps have a 32.4 mgd capacity and four pumps have a 46.1 mgd capacity (Ref. 4). Dry pit submersible pumps were installed to allow for continued pumping during a flooded condition. The pumping systems included external motor cooling using a closed loop system.

Preliminary Treatment

Four mechanical bar screens remove large materials from the wastewater stream entering the wastewater plant. The materials are compacted through the use of two screening conveyors and screening compactors, then dropped into a hopper and discharged into a truck loading area.

The bar screens are installed in 7 feet wide channels. Provisions for two additional screens are included. Each screen has a 60 mgd capacity for an initial firm capacity of 180 mgd (Ref. 4). The screening conveyors have 24 inch wide belts with a 3 inch corrugated edge that take screenings to a dewatering press (compactor). The wastewater removed during this process then flows to the grit separators.

Four forced vortex type grit removal basins are provided to remove sand and grit. These are located downstream of the mechanical barscreens. Grit removal pumps are dedicated to each basin with two common spares. The pumps are 6 inch torque flow units.

Grit is dewatered in two vortex type classifiers and then is conveyed to grit storage and truck loading hoppers.

Flow from preliminary treatment goes through two 10 foot parshall flumes and then to the headworks effluent flow splitting structure. The flow split is designed to limit flow to Plant No. 1 primary treatment, or Plant No. 2 flotation clarifier. The flow split is controlled automatically whereby flows above a set limit bypass the primary clarifier flow splitting structure and are delivered to the wet weather primary treatment facilities.

Primary Treatment

There are 6 primary clarifiers in two groups: 4 units (Phase 1A) and 2 units (Phase 1B, expandable to 4 units). Raw sewage from the headworks flows through two 96 inch diameter transport lines to the two primary influent flow splitting structures. The flow to individual clarifiers may be isolated at these structures.

The primary clarifiers are 140 foot diameter circular units that have a capacity of approximately 15.5 mgd. The sidewater depth is 10 feet. The clarifiers are elevated to match the hydraulic grade line and fill is used to raise the grade in the clarifier area. The clarifiers have effluent level maintenance valves to maintain a set primary effluent level in the effluent launders. The effluent level control was installed to minimize hydrogen sulfide generation, by minimizing turbulent flow over the launders. The clarifiers are not covered although the side walls were designed to accommodate lightweight aluminum covers in the future.

Polymer addition facilities are provided for chemical enhanced primary treatment and are described below. Ferric chloride addition can be added at the headworks flow splitting structure, upstream of the primary clarifiers. Polymer may be added as the flow is split to the individual clarifiers.

Thickened primary sludge is withdrawn from the clarifier under flow. The sludge system is described below. Two below grade primary sludge pump stations are provided for sludge pumping. Primary scum is collected in individual troughs in each clarifier and flows by gravity to a scum wet well in the sludge pump station (PS).

Primary effluent is conveyed in 84 inch diameter lines to an automatic flow splitting structure at the inlet to the aeration basins. The return activated sludge can be mixed with primary effluent at this point and distributed to both secondary treatment process trains.

Secondary Treatment

Secondary treatment at the Plant No. 1 consists of two separate conventional air activated sludge process trains: the original 1976 facilities, and the facilities built during the Phase 1A and Phase 1B expansions. These are briefly described below. A listing of the treatment units physical characteristics is included in Appendix B.

Original Facilities

The system includes 4 earthen aeration basins, each 170 feet square and approximately 18 feet deep. Water depth varies from 14 to 16 feet. The basins have 1:1 side slopes and are lined with a shotcrete type of mortar. A fine bubble ceramic disk diffuser system retrofit was installed in the basins and supplies air for biological treatment. The oxygen transfer efficiency for this system is estimated to be 7 percent.

A spray water system is used for foaming control, and is tied to the non-potable water system.

Aeration air is supplied to the system from three multistage centrifugal blowers. These units have a capacity of approximately 18,000 cubic feet per minute (cfm) each or a total of 54,000 cfm. The system control is based on the aeration basin effluent dissolved oxygen (DO) levels. Blower output is varied by throttling a valve on the inlet of the blower . The blowers have two-stage inlet filters. This blower system is interconnected with the Phase 1A/1B blower system to provide standby capacity to the newer system. Similarly, a 24-inch air line can supply air to the original aeration basins system from the Phase 1A/1B blower system.

The aeration basin mixed liquor flows to five secondary clarifiers. Four of these are the original square units, approximately 150 feet square on each side with a side water depth of approximately 14 feet. A fifth circular unit (140 feet diameter) increases the reliability and capacity of the final clarifiers. These clarifiers have hydraulic type rapid sludge withdrawal mechanisms. Secondary scum is collected in two common sumps and pumped to the digesters.

A return activated sludge/waste activated sludge (RAS/WAS) pump station, located to the east of the five clarifiers provides secondary sludge pumping. Three vertical wet pit centrifugal pumps provide approximately 50 mgd of RAS pumping capacity. A fourth pump is a standby unit. Four dry pit centrifugal WAS pumps provide 4.3 mgd of capacity. A fifth pump serves as a standby. The RAS system is controlled by the RAS wet well level. The WAS pumps are variable speed with manual speed adjustment. In the Phase 1A expansion, three of these pumps were retrofitted to provide remote controls. The RAS may be piped to mix with the common primary effluent or returned directly to the aeration basins in this process train.

A Liquid Oxygen (LOX) system was added in 1992 to supplement the original aeration system capacity. This is described below.

Phase 1A/1B Facilities

The Phase 1A and 1B system includes aeration basins, secondary clarifiers, blower facility and RAS/WAS pump station, described below.

The four aeration basins are rectangular, approximately 260 long by 135 wide and are constructed adjacent to each other using common wall construction. These units have the capability for future conversion to nutrient removal.

The flow enters each basin through individual flumes then through a series of six compartments. The first compartment provides an anoxic zone for control of filamentous organisms. The remaining compartments are supplied aeration air from a fine bubble diffuser system. Flow metering of the primary influent to each basin is provided.

Each aeration basin has dissolved oxygen (DO) monitoring capability at each compartment. Two DO meters are installed to provide DO measurements in two compartments and may be relocated to other compartments as needed. Additionally, foam control spray nozzles are installed on each basin. These use non-potable water for foam control.

The secondary treatment train for the Phase 1A/1B supplies air from a dedicated aeration blower system. Four single-stage centrifugal units provide approximately 27,000 cfm each for a total of 81,000 cfm of capacity. These units are located in a blower building east of the aeration basins. A 60 inch air header supplies air from the blower station to the basins. The blowers are controlled by maintaining a set pressure in the aeration header system, and the feed to the aeration basins is controlled with discharge butterfly valves by basin DO.

Eight rectangular secondary clarifiers, each 240 feet long by 40 feet wide, provide final treatment prior to discharge to the effluent disposal system. The units have a sidewater depth of 13 feet. The approximate capacity of each of these units is 5 mgd for a total capacity of 40 mgd. A distribution and feed channel at the influent feeds the clarifiers through submerged gates. Secondary scum is collected in an adjacent trough and discharged to a scum wet well. Sludge is withdrawn by two longitudinal collectors which move sludge to a hopper, and by cross collectors which move the sludge to the outlet.

A RAS/WAS pump station is located to the south of the clarifiers. Secondary sludge flow to the RAS wet well is controlled by flow control valves on each sludge discharge line to the RAS wet well. Three horizontal non-clog dry pit centrifugal plus one standby are used for RAS. The RAS pumping capacity for each pump is approximately 10 mgd, with variable frequency drives (VFD) that provide a wide range of flows. Two WAS pumps plus a standby pump waste sludge to solids treatment. Each pump has a capacity of approximately 2.5 mgd. They are similar in type to the RAS pumps, and also have VFDs.

Effluent Reuse and Disposal

The effluent disposal system consists of a distribution system (canals, laterals, and ditches), infiltration beds, water reclamation wells and pipelines. About ten percent of the treated effluent is conveyed by the canals and pipelines to nearby farms for direct irrigation. The effluent reuse and disposal facilities are presented in Figure 3.

Secondary effluent is conveyed from Canal A and High ditch, Annadale ditch, Low ditch and Lateral No. 2, then discharged to the infiltration beds. Plant No. 2 secondary effluent can be discharged either the Canal B, for distribution to the infiltration beds, or it can be pumped to Plant No. 1 for additional treatment. Flow through the canals is regulated by a series of slide gates and weir boards at flow control structures.

Pipelines are also used to transfer effluent directly to irrigation uses at the ends of several of the canals. The pipelines were originally installed with propeller meters. These include:

1. High Ditch: A 36 inch irrigation line splits to two separate 24 inch lines to supply irrigation users. One of these is currently in operation and the second to the North is no longer in operation.

2. Annadale Ditch: A 30 inch irrigation line goes to the South and is used to supply irrigation users to the west and north of Dry Creek.

3. Lateral No. 2: A 36 inch irrigation line goes to the area south of the existing beds. This has been extended south , approximately 1/2 mile, across Central Avenue.

4. Low Ditch: A 30 inch irrigation line extends to the south from Low Ditch. This currently is used intermittently, during drought periods.

5. Canal A: A 24 inch line that has not been used recently, was reported as broke. There currently is little demand for reclaimed water in this direction.

6. Canal A at Secondary Clarifiers: An 18 inch irrigation line feeds to the North and east of the Plant. This may have capacity problems and could reported be increased when the land to the east is irrigated.

7. Canal B: Irrigation line to the east of Plant No. 2 has limited capacity.

The existing infiltration beds cover an area of approximately 1,650 acres and have a net infiltration area of about 1,414 acres (less roadways and canals). The beds are rectangular in size and range from about 8 acres to almost 30 acres. Additions to the pond system are currently planned and include approximately 320 acres (272 acres net).

A series of reclamation wells pump from the shallow ground water table beneath the ponds to control the volume of water that percolates into the shallow zone. Approximately 10,000 to 30,000 ac-ft per year are pumped to the Fresno Irrigation District (FID). The recycled water is pumped to one of several main reclamation pipelines or directly discharged to FID facilities, via either Dry Creek or Houghton Canal. The reclamation wells north of Dry Creek discharge to a 48 inch pipeline which delivers the water to Houghton canal outfall line at West Jensen Avenue. Reclamation wells R2, R3, R4 and R5, south of Dry Creek, discharge to a 30 inch reclamation line which then discharges to the creek. Several wells including R8, R21 and R20 discharge directly to Dry Creek.

WINERY STILLAGE

A 95 acre area west of Plant No. 1 is provided for the treatment and disposal of stillage from local wineries. The stillage is sent to 156 beds or "checks" where it is applied 4 inches thick and allowed to dry. The dry beds are scraped and disced to 6 inches before wet stillage is applied again. The quantity of stillage treated at the RWRF varies from 0.1 mgd to 1.0 mgd with the majority being delivered from August to November.

SOLIDS STREAM TREATMENT

The existing RWRF solids stream treatment system consists of screening and grit removal, primary and secondary sludge processing (thickening, digestion, dewatering).

Screenings

Screenings from the headworks are transported by truck to the local landfill for disposal. Screenings from the new bar screens are dewatered in screenings compactors, then discharged to a storage hopper (15 cubic yard capacity). The hopper is located above grade for truck loading.

Grit

The grit removal system is located at the headworks. The grit from the grit removal tanks is pumped to classifier/dewatering units for treatment and then discharged to two 16 cy hoppers. These hoppers are located adjacent to the screenings hoppers. Grit is also disposed of at the local landfill.

Primary Sludge

Each of the two groups of primary clarifiers (4+2) has its own dedicated primary sludge pump station. Thickened primary sludge is pumped from the primary clarifiers directly to anaerobic digesters. The primary sludge is pumped from the clarifier underflow using air operated diaphragm pumps. Each clarifier has 2 dedicated pumps and one standby pump with a capacity of 140 gallons per minute (gpm). The sludge is pumped from the primary sludge pump station to the digester complex in one of two glass lined primary sludge transport lines. These lines run through the north-south utility tunnel. The lines can be individually isolated and steam cleaned.

Primary sludge solids are monitored using a density meter at the pump station. Flow may be determined by the rate of pumping by the diaphragm pumps.

Primary scum is collected in each clarifier and flows by gravity to a common scum well at the primary sludge pump station. The scum well is agitated by two scum mixers and pumped into the primary sludge line for delivery to the anaerobic digesters.

WAS Sludge Thickening

The WAS from the RAS/WAS wet wells is pumped to two different processes for thickening: dissolved air flotation thickeners (DAFT) or gravity belt thickeners (GBT).

The two 40 foot diameter DAFT units were installed in 1986. The units have individual bottom sludge pumps, thickened sludge pumps and pressurization systems. Two progressing cavity type pumps are used for bottom sludge and are rated at 50 gpm. Two pumps are used for thickened sludge (float) and are rated at 200 gpm. A polymer system is provided for conditioning the WAS prior to thickening.

In addition to the DAFT facility, Plant No. 1 also has two 2-meter GBT units located at a temporary outdoor facility. Polymer solution is used to enhance thickening and process performance. The GBT facility includes filtrate pumps, thickened sludge sump and pumps and polymer systems. The hydraulic loading rate of the press is limited to 150 to 250 gpm per meter.

Sludge Digestion

Waste activated sludge (WAS) and primary sludge are processed by anaerobic digestion, which converts volatile solids to gas and liquids and "stabilizes" the sludge. The system includes 12 digesters built during various projects from 1976 to the Phase 1B expansion project. The digester sizes and details are noted in Appendix B.

Digesters 1,2,5, 6, and 8 - 12 have fixed reinforced concrete domed covers which provide a gas tight enclosure. Digesters 3, 4 and 7 have steel gas holder floating covers. The floating cover elevations vary with the amount of sludge in the system and the gas pressure in the system. All digesters have pressure relief / vacuum vents, and all but Nos. 3, 4 and 7 have as well as gas drawoff systems on the roofs. Digesters 1 - 5 and 9 - 12 have pump mixing systems while the others have gas recirculation mixing.

The digesters are fed through a set of pneumatically operated valves. Each digester is fed a portion of primary sludge and thickened secondary sludge based on the digester size. The feed primary sludge is heated in a sludge heat exchanger before entering the digester. The feed system is automated and controlled by the new distributed control system. The digester overflow is conveyed to one of two holding digesters (Nos. 1 or 2) which are used to blend the various flow streams prior to dewatering.

The digesters are continuously heated by circulating a portion of the sludge through a dedicated heat exchanger and returning it to the digester. The sludge heating system for each digester consists of a heated sludge recirculation pump, heat exchanger, hot water circulating pump, a 3-way hot water mixing valve and associated controls.

Sludge Dewatering

The anaerobically digested sludge is dewatered using belt filter presses (BFPs) at Plant No. 1. Seven BFPs are located in the dewatering facility. Two digested sludge transfer pumps are used to feed the dewatering facility from one of two holding digesters (Nos. 1 or 2). Two sludge grinders are used to grind the digested sludge and any foreign matter that may be in the sludge.

Individual feed pumps control the flow of sludge to each BFP. Polymer solution is also injected into the sludge for improved dewatering. The BFP units dewater the sludge from 1.5 to 2.5 percent solids to 16 to 20 percent solids sludge cake and capture from 90 to 95 percent of the solids applied to the BFP.

Each BFP is a self contained unit that can be operated in combination with any other unit. This includes the feed pump and polymer metering pump. Each BFP is a 2-meter unit with a minimum feed capacity of 125-150 gpm/meter.

The dewatered sludge is collected along a sludge conveyor and then transferred to a second conveyor. The dewatered sludge is stored in a storage silo for truck loading after which it is transported off site for reuse. The silo provides storage for weekend periods and other times when sludge transport is not possible.

DESCRIPTION OF SUPPORT FACILITIES

Chlorination

The RWRF has two chlorination systems: an older ton cylinder liquid/gas chlorine system and a newer sodium hypochlorite system. The chlorine gas system was installed in the 1976 improvements and has not been upgraded to today's safety standards for chlorine storage. The system can be used to chlorinate secondary effluent, influent interceptors and RAS flows. In most instances, only the RAS chlorination system has been operated, although influent chlorination has been used intermittently to control odors.

In addition, a small gaseous chlorine system is used to treat the largest potable water well and a small hypochlorite system is used to treat well water at Plant No. 2.

The sodium hypochlorite system includes two distribution systems: One system is used for the headworks odor scrubbers and the second for chlorination of RAS flows or secondary effluent (3W) used for on-site reuse. The hypochlorite system includes 3 storage tanks and five chemical metering pumps located at the headworks. The tank and pump sizes are listed in Appendix B.

Headworks Odor Control

Three odor control scrubbers are provided at the headworks for the control of odor-causing off gases, such as hydrogen sulfide, ammonia, mercaptans and other volatile malodorous compounds. Each system pulls approximately 30,000 cfm from different areas of the headworks. The areas include: the influent wet wells, the grit channels and bar screen room, and the grit room and grit and screening storage areas. The scrubbers use sodium hydroxide and sodium hypochlorite for scrubbing chemicals.

Water Systems

The RWRF has three water systems. The fire water (FW) and 1W system is supplied by three dedicated wells (Nos. 1, 2, and 3) and provides potable water for potable water usage. The 2W water system is a non-potable well water system that supplies undisinfected groundwater for process use, including pump seals and chemical makeup. The 3W water supplies chlorinated plant effluent for foam control sprays, irrigation and other uses. These systems are distributed throughout the plant by dedicated and separate piping systems.

Digester Gas Utilization System

Digester gas is collected from the 8 or 9 operating digesters and can be used in the hot water boiler or flared in the new enclosed waste gas burner. Digester gas can also be used in the engine-generators at Power Generation Facility (PGF). The hot water boiler can be fired using the digester gas and the hot water produced may then be used to heat feed sludge to the digesters. A new PGF system, utilizing gas turbines and providing capacity from 6 - 12 megawatts, is being installed as part of the Phase 1B expansion. The original PGF building and engines will be decommissioned after construction of the new PGF system is completed (anticipated in late 1998).

Power Distribution System

The Fresno-Clovis RWRF is supplied power from PG&E through the utility's 12 kVA distribution system from the north side of the plant. Two circuits are provided, which come from a remote substation. One circuit supplies the entire load and is the usual power source. The second circuit has a limited capacity and is used only for essential loads. The PG&E facilities terminate at a metering station near the septage receiving station. City-owned, underground, feeder cables provide incoming power to the main 12 kVA switchgear building.

The main switch gear circuit breakers supply 12 kVA underground feeders which serve the various load areas. Load area substations transform the primary voltage to consumption voltage (4,160 or 480 volts).

Control Systems

The RWRF has an on-line distributed control system (DCS). The DCS consists of a base system serving the 68 mgd facility (installed during the Phase 1A expansion project) and will be expanded to include facilities added during the Phase 2A expansion. The DCS configuration includes a network of programmable logic controllers (PLCs) with a peer-to-peer communication system using fiber optics. Also on the network are IBM PC-compatible Operator Interface Stations (OISs). The PLCs are able to communicate directly with each other to exchange information required for process loops. The OISs have access to any data on the PLC network.

High Pressure Air System

The RWRF utilizes a plant-wide high pressure air system. Two 540 cfm air compressors provide 125 pounds per square inch (psi) air for the system. The units are located in the High Pressure Air/Boiler Building, located north of Digester No. 10.

Chemical Storage and Feed

The headworks includes chemical storage and treatment systems for hydrogen sulfide control. Bulk chemical storage is provided for ferric chloride, sodium hypochlorite, and sodium hydroxide. These chemicals are pumped to treatment points using diaphragm metering pumps dedicated to each service. The size and capacity of these systems are described in the Appendix B.

Drain Pump Stations

The existing RWRF facilities contain four drain pump stations. The pump stations are the: Site Drain/Waste pump station (PS), Plant Drain PS No. 1, Plant Drain PS No. 2, and the Tank Drain PS. Three of the pump stations were built during the Phase 1A expansion. The fourth pump station (Plant Drain PS No. 2) is being built during the Phase 1B expansion.

The Site Drain/Waste PS collects stormwater, process, and washdown drainage from the older parts of Plant No. 1. The drainage is collected in a sump, then pumped to the headworks by three submersible non-clog centrifugal pumps (1,500 gpm capacity, each). The pump station operation is based on sump water level, and the pumps automatically alternate between lead, lag and standby. The pumps discharge to a pressure main that goes to the new headworks.

The Plant Drain PS No. 1 collects the stormwater, process drainage and wash down from the Phase 1A facilities. It is located north of the primary clarifiers adjacent to the digester area. The pump station contains three submersible non-clog centrifugal pumps, each with a capacity of 1,800 gpm. The pumps discharge to a pressure main that goes to the headworks.

Plant Drain PS No. 2 is located south of the secondary sedimentation basins, and west of the RAS/WAS pump station. This PS will collect stormwater, process drainage and washdown from the Phase 1B facilities, and graded and/or paved areas adjacent to and south of the 1B facilities. The PS contains three pumps, identical to those in Plant Drain PS No. 1.

The Tank Drain PS is used to drain the Phase 1A/1B aeration basins and secondary clarifiers. It is located along the north wall of the secondary clarifiers. The pump station includes two submersible non-clog centrifugal pumps each with a capacity of 1,800 gpm. The pumps discharge to a pressure main that goes to the headworks.

Administrative/Laboratory Services

The present administrative building consists of a temporary office trailer and the original laboratory/administrative building. The original buildings were constructed in 1976-1978 expansion. Construction of the new administration/laboratory complex is scheduled to begin in 1998. Construction of the new maintenance building and warehouse are scheduled to begin in 1997.

REFERENCES

1. CH2M-Hill. Wastewater Facilities Master Plan, July 1989.

2. JCE. City of Fresno, Primary and Secondary Treatment; Preliminary Design. June 1991.

3. Phillips, Chad. Evaluation and Plan for Disposal of Effluent During Wet Weather. September 1994.

4. HDR Engineering, Inc. Fresno-Clovis Regional Wastewater Reclamation Facilities, Headworks Predesign Report. October 1991.

5. Jenks and Harrison. City of Fresno, Operations and Maintenance Manual, Wastewater Treatment Plant, Revised for 1974-1976 Improvements, December 1976.

Fresno-Clovis Regional
Wastewater Reclamation Facilities

MASTER PLAN REPORT

TASK 600
TECHNICAL MEMORANDUM NO. 3

EVALUATION OF REGIONAL TREATMENT PLANT EXPANSION AND CAPACITY OF EXISTING FACILITIES

July 1996

W:\4030A00\600TM3.COV

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES
MASTER PLAN REPORT

TASK 600
TECHNICAL MEMORANDUM NO. 3
EVALUATION OF REGIONAL TREATMENT PLANT EXPANSION
AND CAPACITY OF EXISTING FACILITIES

TABLE OF CONTENTS

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES
MASTER PLAN REPORT

TASK 600
TECHNICAL MEMORANDUM NO. 3
EVALUATION OF REGIONAL TREATMENT PLANT EXPANSION AND CAPACITY OF EXISTING FACILITIES

TABLE OF CONTENTS
(Continued)

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES
MASTER PLAN REPORT

TASK 600
TECHNICAL MEMORANDUM NO. 3

EVALUATION OF REGIONAL TREATMENT PLANT EXPANSION
AND CAPACITY OF EXISTING FACILITIES

LIST OF TABLES

FRESNO-CLOVIS REGIONAL WASTEWATER RECLAMATION FACILITIES
MASTER PLAN REPORT

TASK 600
TECHNICAL MEMORANDUM NO. 3

EVALUATION OF REGIONAL TREATMENT PLANT EXPANSION AND CAPACITY OF EXISTING FACILITIES

LIST OF FIGURES

EVALUATION OF REGIONAL TREATMENT PLANT EXPANSION AND CAPACITY OF EXISTING FACILITIES

INTRODUCTION

The purpose of this technical memorandum (TM) is to develop recommendation for future facilities at the Fresno-Clovis Regional Wastewater Reclamation Facilities (RWRF). The capacity of existing facilities is also discussed and is used as a basis for evaluating future facility needs.

Planning for future facilities is based on: projected flows and loads established in Task 400 TM 2; projected sludge quantities established in Task 900 TM 1; and master plan design and standby criteria developed in Task 300 TM 1. Additional discussion of existing facilities and their historical performance are found in Task 200 TMs 1 and 2, respectively.

Terminology of flow and load conditions to be used throughout this TM are shown in Table 1. Projected flows and loads used in evaluating future facility needs are presented in Table 2.

OVERALL APPROACH

The objective of this Master Plan is to provide a program to implement recommended facilities for a 25 year planning period through the year 2020. The recommended facilities must, therefore, provide treatment to accommodate future growth and regulatory requirements, and must also meet the specific needs of reuse and disposal alternatives.

This evaluation of future facilities focuses on meeting treatment needs. The approach to this evaluation is to identify the capacity of the existing secondary treatment unit processes and compare this capacity to projected future needs for differing treatment scenarios. The treatment scenarios considered are as follows:

Scenario 1: Assumes future facilities required to accommodate growth and to continue the existing level of conventional secondary treatment. This is the base case, or minimum level of treatment required to meet existing regulatory requirements.

Scenario 2: Assumes pathogen reduction by disinfection as the next level of treatment required to meet regulatory requirements for disposal or reuse of treated effluent. Filtration is also assumed as needed for specific reuse alternatives.

Scenario 3: Assumes removal of nitrates and/or phosphorus will be required for land disposal and river disposal, respectively. Treatment to remove nitrates and phosphorus requires Biological Nutrient Removal (BNR).

Table 1 Wastewater Flow and Loading Definitions Fresno-Clovis Wastewater Master Plan		
Term	**Definition**	**Purpose**
ADWF	<u>**Average Dry Weather Flow**</u> The average flow occurring over the three consecutive lowest flow months of the year. The ADWF typically occurs in February, March and April.	To develop base wastewater flow projections and for scheduling unit process down time.
ADWL	<u>**Average Dry Weather Load**</u> The average organic or suspended solids load occurring over the three consecutive lowest load months of the year. The ADWL typically occurs in May, June, and July.	To develop base wastewater load projections and for scheduling unit process down time.
ADAF	<u>**Average Day Annual Flow**</u> The average daily flow based on the calendar year.	Sizing of wastewater treatment facilities.
ADAL	<u>**Average Day Annual Load**</u> The average daily load based on the calendar year.	Sizing of wastewater treatment facilities.
ADMMF	<u>**Average Day Maximum Month Flow**</u> The average daily flow occurring during the maximum flow month of the year. The ADMMF is typically during the month of September during peak food processing season.	Sizing of wastewater treatment facilities.
ADMML	<u>**Average Day Maximum Month Load**</u> The average daily organic or suspended solids load occurring during the maximum load month of the year. The ADMML for organic load is typically during the peak food processing month of September. The ADMML for suspended solids is typically in December, most likely due to wet weather events.	Sizing of wastewater treatment facilities.
PHWWF	<u>**Peak Hour Wet Weather Flow**</u> The peak hour treatment plant inflow resulting from the design rainfall event. The PHWWF typically occurs during the wet weather period of December through March.	To set plant hydraulic conveyance capacity.

Table 2 Projected Plant Influent Flows and Loads[1] Fresno-Clovis Wastewater Reclamation Master Plan				
Year	Condition	Flow, mgd	BOD_5, ppd	TSS, ppd
2000	ADW	84	213,000	235,000
	ADA	89	245,000	289,000
	ADMM	95	307,000	383,000
2005	ADW	101	271,000	310,000
	ADA	107	311,000	381,000
	ADMM	115	390,000	506,000
2010	ADW	118	328,000	385,000
	ADA	125	377,000	474,000
	ADMM	135	472,000	628,000
2015	ADW	136	386,000	460,000
	ADA	144	443,000	566,000
	ADMM	155	555,000	750,000
2020	ADW	153	443,000	535,000
	ADA	162	509,000	659,000
	ADMM	174	638,000	873,000
(1) Values based on trend of historical flows and loads. See Task 400 TM 2.				

Scenario 4: Assumes total dissolved solids (TDS) and electrical conductivity (EC) will become a regional groundwater concern. Treatment to remove TDS and EC requires reverse osmosis (RO).

These scenarios were developed previously in Task 700 TM No. 5 and are considered to be the most probable levels of treatment which may be required for future regulatory changes, and/or reuse and disposal options.

The future facilities evaluation also includes a sensitivity analysis of conventional secondary treatment processes to account for potential changes in operation or changes in influent condition. Projected influent flows and loads to the RWRF differ depending on projection method and/or implementation of satellite plants. Implementation of satellite plants is discussed in Task 800 TM 1.

The evaluation of treatment facilities also includes a review of planning considerations and other key issues which will influence facility siting and phasing of recommended upgrades, as discussed below.

PLANNING CONSIDERATIONS

This TM focuses on future facility needs based on projected flow and load, so the layout of future facilities is not specifically addressed in this TM. (Layouts of future facilities are included in Task 1100 TM No. 1 "Master Planned Future Facilities Requirements.")

There are, however, several basic planning concepts and principles relative to layout that were followed in master planning the future facility requirements. These include:

1. Utilizing treatment processes which are the same or similar to existing facilities, where possible, to minimize the number of different unit operations for simplicity.

2. Sizing process units to match existing units, where possible, for uniformity and symmetry of layout.

3. Providing a flexible layout to accommodate a variety of future treatment processes, and to reserve space for future facilities.

KEY ISSUES

Future facility needs will be most strongly influenced by two factors, level of treatment and capacity. In addition to these factors, there are four other key issues that are addressed in this TM:

1. Increasing BOD_5 and TSS concentrations.

2. Facility needs for land-based treatment.

3. Buffer land management and utility corridor constraints.

4. Utilization of Plant 2

Increasing Concentrations

Historical flow, BOD_5 and TSS influent concentrations have increased significantly over the last five years as shown in Table 3. The future loading to the plant, based on a trend of the historical loads, is also expected to increase.

Table 3 Historical and Projected Influent Characteristics Fresno-Clovis Wastewater Reclamation Master Plan						
Parameter	Units	Historical 1990	Historical 1995	Projected 2020	% Increase 1990-1995	% Increase 1995-2020
ADWF	mgd	49	68	153	138	225
BOD_5[(1)]	lbs/day	96,000	164,000	443,000	170	270
	mg/L	235	289	347	123	120
TSS[(1)]	lbs/day	83,000	166,000	535,000	200	322
	mg/L	203	292	419	143	143
(1) ADWL Value						

The capacity rating of individual unit processes at the RWRF can be categorized as either flow-based or load-based. The observed phenomena of increasing concentrations impacts facility requirements for the load-based treatment facilities such as aeration basins, solids thickening and solids dewatering. This is because the increasing concentration (i.e., increased load) will cause these load-based facilities to reach capacity sooner than flow-based facilities such as headworks and primary/secondary clarifiers. If the BOD_5 and TSS continue to increase as projected, there is a potential imbalance of facilities which treat load versus facilities which treat flow. The effects of this potential imbalance of facilities is, therefore, evaluated further for each impacted unit process.

Land-Based Treatment Facilities

The RWRF has historically utilized the City-owned land for disposal and/or treatment of residuals, wine stillage, and effluent. Each of the treatment/disposal processes for residuals, stillage, and effluent will require space allocation for future operations. Likewise, residuals handling and stillage treatment may also require facility upgrades in the future. Future land requirements and upgrades for these purposes are discussed in the following sections: Effluent Reuse/Disposal and Distribution Facilities, and Ancillary/Support Facilities.

Buffer and Utility Corridors

Planning for future facilities must provide for buffer land around the plant site and for future utility corridors. The land north of the Plant 1 facilities and south of Jensen Road, as shown on Figure 1, is planned for buffer and will not have any treatment facilities. Designating this area as buffer serves two purposes: to provide approximately 500 feet of separation between potential residents north of Jensen Avenue (to avoid odor complaints) and to prevent construction in proximity to the high voltage lines and towers sited on the property. Also shown in Figure 1, the

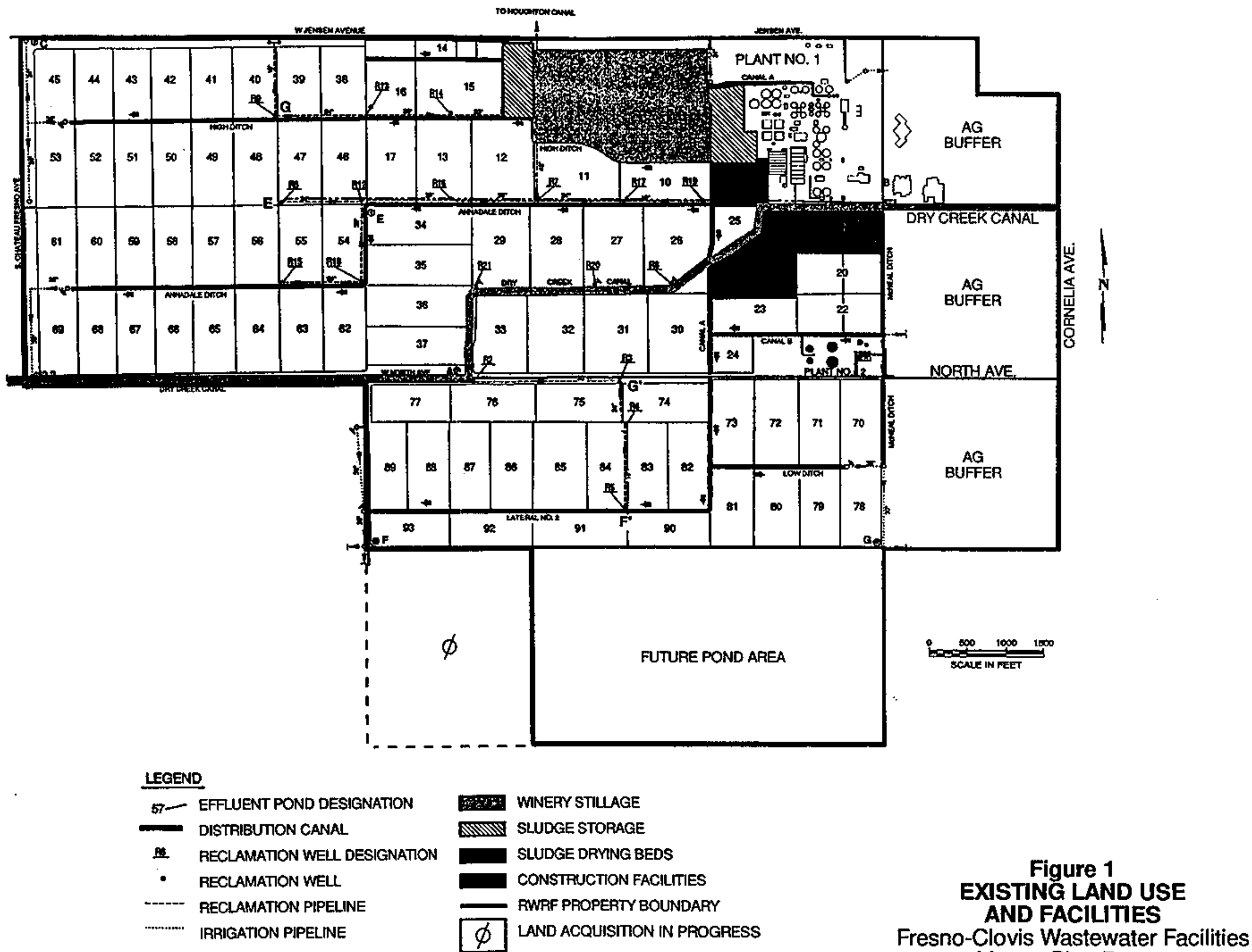


Figure 1
EXISTING LAND USE AND FACILITIES
Fresno-Clovis Wastewater Facilities
Master Plan Report

FR798F1.CDR

strip of land north of the new headworks building is planned for buffer area. This area will provide buffer between the plant site and the proposed administration building (east of the plant) and will prevent construction over the existing sewer interceptors. Proposed buffer areas around the perimeter of the plant are shown on Figure 1.

Utility corridors for future facilities are planned in a grid pattern parallel to planned expansion from north to south and process flow from east to west. Two main corridors are planned for process piping: 1) extension of existing utility tunnel between the primary clarifiers and aeration basins; and 2) east of the primary clarifiers in parallel to the primary influent pipelines. Primary electrical service for subsequent expansions will also run in a north/south direction in corridors between primary clarifiers and aeration basins and also between the aeration basins and secondary clarifiers. East/west corridors for process piping and/or electrical service will be provided at the southern edge of each phased expansion.

Plant 2

Plant 2 has historically been utilized to treat a portion of the influent flow. Plant 2 currently treats up to 8 million gallons per day (mgd), approximately ten percent of the ADAF (1995-96). However, as flows increase in the future, the percentage of treatment capacity provided by Plant 2 will decrease. Considering this, one of the key planning issues that must be addressed is how to use Plant 2 facilities in the near and/or long-term.

Plant 2 consists of one flotator clarifier, two trickling filters, and two final clarifiers. The trickling filters and final clarifiers were constructed in 1962 and the flotator clarifier in 1976. Thus, a primary factor in continued use of Plant 2 is age/longevity of the existing facilities. Some facilities upgrades were completed in 1993 but these upgrades were intended as interim upgrades focused on improved treatment performance. Significant additional facility upgrades for replacement of aged an/or worn equipment, will be required to maintain reliable performance from the plant as shown in Appendix A.

A second factor regarding the continued use of Plant 2 is cost for operation and maintenance. Because Plant 2 is a separate treatment plant and is remotely located from Plant 1, it must be staffed separately. As shown in Appendix A, costs to staff Plant 2 ($/mgd capacity) are approximately twice those of Plant 1. Operational costs are also high for the plant, due in part to the lack of solids handling facilities which necessitates pumping of solids to Plant 1 for treatment. The reliance on Plant 1 for solids treatment also complicates operation of the plant.

Based on discussions with City staff it has been long realized that the age of the Plant 2 facilities and the cost of operation will preclude continued long-term operation. With this in mind, Plant 2 has been used for the past several years to provide interim capacity for the increasing flows until additional treatment capacity could be constructed at Plant 1. It is anticipated that Plant 2 will remain in service until after completion of expansion to 98 mgd. Based on flow projection estimates, expansion of Plant 1 to 98 mgd will need to be completed in the year 2000.

After completion of the expansion, it is assumed that Plant 2 will be decommissioned. For planning purposes, it is assumed that the "short-term" upgrades identified in Appendix A (i.e., upgrades to extend the reliable useful life of the facilities from 1996 through 2001) will be implemented.

CAPACITY OF EXISTING FACILITIES

As part of any long-range planning process, the capacity of existing facilities must be evaluated and quantified so that the type, size and timing of future facilities can be identified. For planning purposes, the capacity of treatment facilities are conservatively defined by applying non-aggressive design criteria, and by providing for reliable treatment with some units removed from service. This approach to defining capacity is prudent for long-range planning but can be overly conservative with respect to short-term operation. For short-term operating conditions, such as may occur during construction of new facilities, the capacity of existing facilities can be determined using alternative criteria.

Figure 2 identifies terms used to quantify capacity relative to three different operational conditions:

Design Capacity: Capacity calculated by applying conservative design criteria and assuming one (or more) treatment units out of service. Design capacity is generally used to establish the size, type, and number of facilities to treat average flow and load conditions.

Peak Capacity: Capacity calculated by applying more aggressive operating criteria (based on plant operating experience) and assuming no treatment units out of service. Peak capacity is used to establish facilities required for maximum month flow and/or load conditions. Peak capacity is intended for interim operation only, so units can be periodically removed from service for maintenance.

Transitional Capacity: Capacity calculated by applying aggressive operating criteria, assuming no treatment units out of service, and assuming application of operational enhancements for improved process performance. Operational enhancements may include chemical addition for improved primary solids removal, or the use of liquid oxygen to increase aeration capacity. Transitional capacity is intended for short-term operation only, for example, during on-going construction of new facilities.

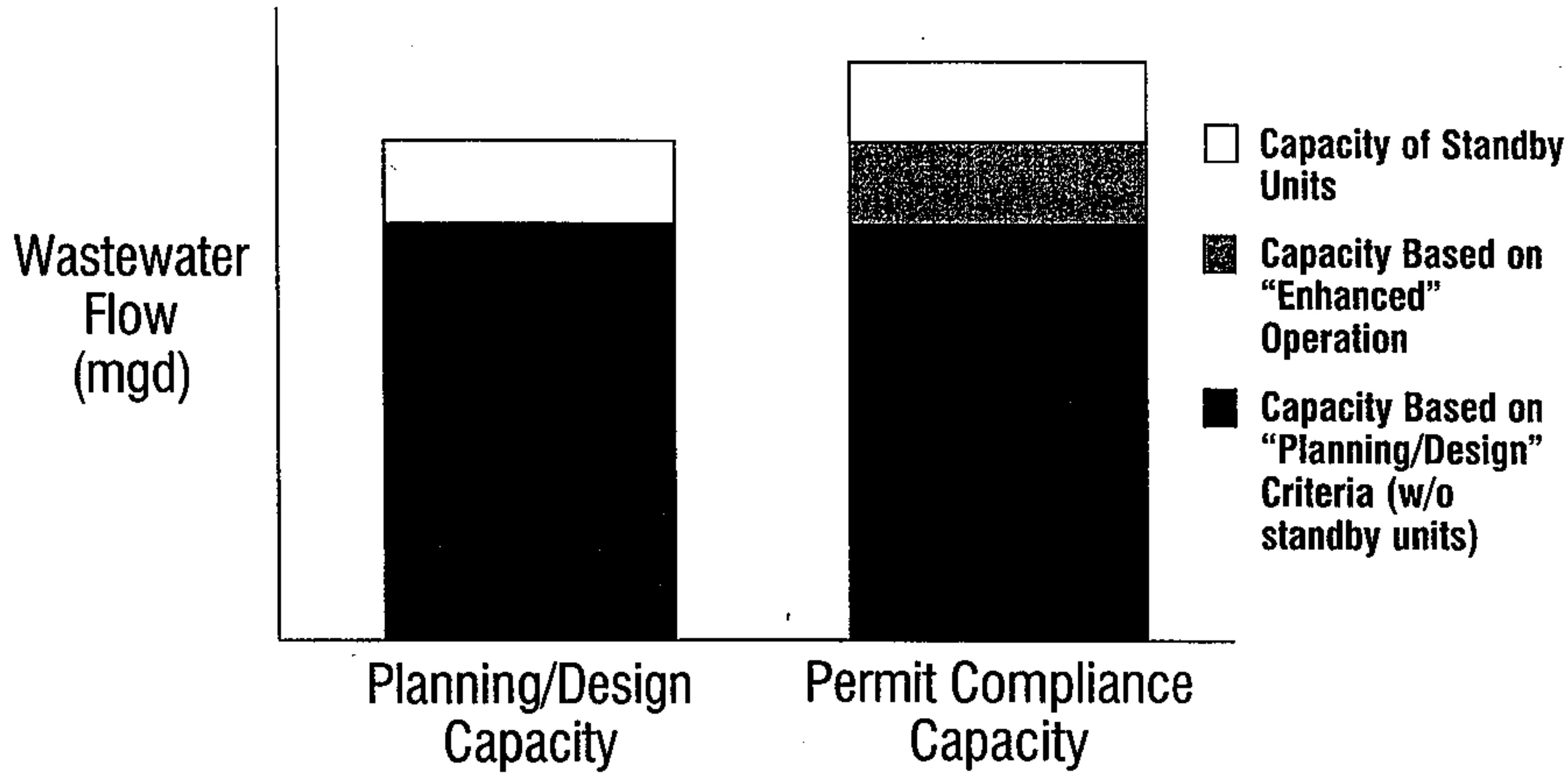


Figure 2
PLANNING/DESIGN CAPACITY VS. PERMIT COMPLIANCE CAPACITY
Fresno-Clovis Wastewater Facilities
Master Plan Report

FR795P1.PPT 7/23/96

The RWRF has been successfully operating above design capacity over the last several years, due primarily to the significant increase in flow and loads during this period. This confirms that design capacity is in fact conservative and provides a factor of safety for unanticipated operation at peak and/or transitional capacity in the short-term. The objective of this master plan is to identify and plan for future facilities using this same conservative philosophy. Therefore, the capacity of existing facilities, including the facilities constructed for the Phase 1B (anticipated completion 1998) have been calculated based on design criteria, as shown in Table 4. However, a capacity analysis of the "transitional" capacity of existing facilities is included in Appendix B. Figures 3 and 4 show the capacity of Plant 1 facilities relative to projected 1998

Table 4 Capacity of Existing Facilities(1)
Fresno-Clovis Wastewater Reclamation Master Plan

Unit Process	Unit	Average Day Annual		Average Day Maximum Month	
		Total Capacity	Reliable Capacity(2)	Total Capacity	Reliable Capacity(2)
Primary Clarifiers	mgd	93	78	101	N/A
Secondary Clarifiers	mgd	82	68	88	N/A
Aeration Basin	Influent BOD_5 ppd	205,000	180,000	224,000	N/A
Aeration Blowers	Influent BOD_5 ppd	320,000	231,000	319,000	230,000
WAS Thickening (DAFTs & GBTs)	Influent BOD_5 ppd	252,000	189,000	---	---
Digestion	Influent TSS, ppd	262,000	228,000	262,000	N/A
Belt Filter Press Dewatering	Influent TSS, ppd	248,000	211,000	248,000	N/A

(1) Based on 1998 projected flow and load, assuming Phase 1B expansion is complete.
(2) Reliable capacity defined as capacity of in-service units -- not considering capacity of standby units.

flows and influent concentrations. Planning for future facilities are based on slightly different design criteria than existing facilities to reflect more recent design concept modifications (ref Task 300 TM 1, Design and Standby Criteria). A summary of key design and standby criteria for future facilities is included in Appendix C.

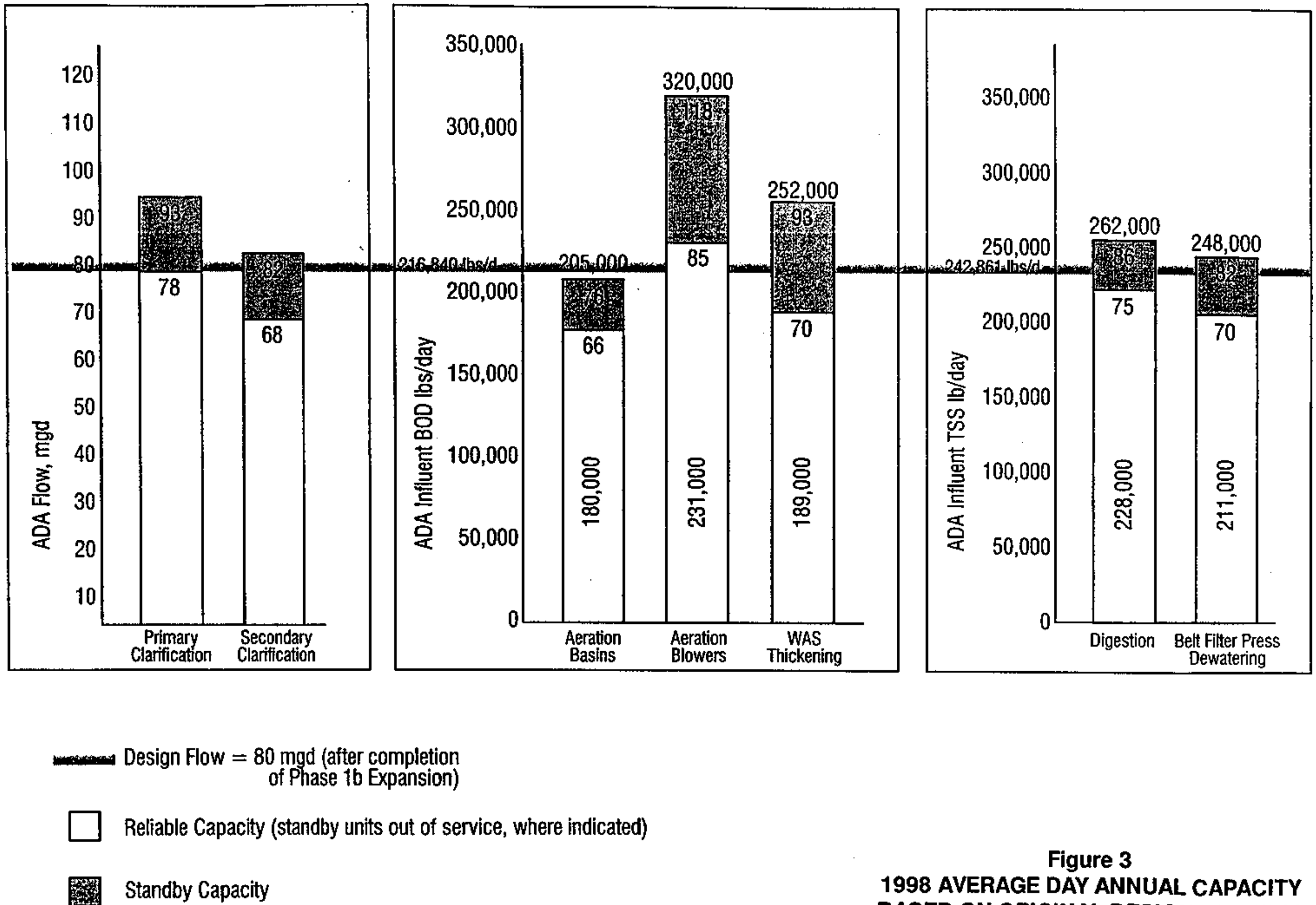
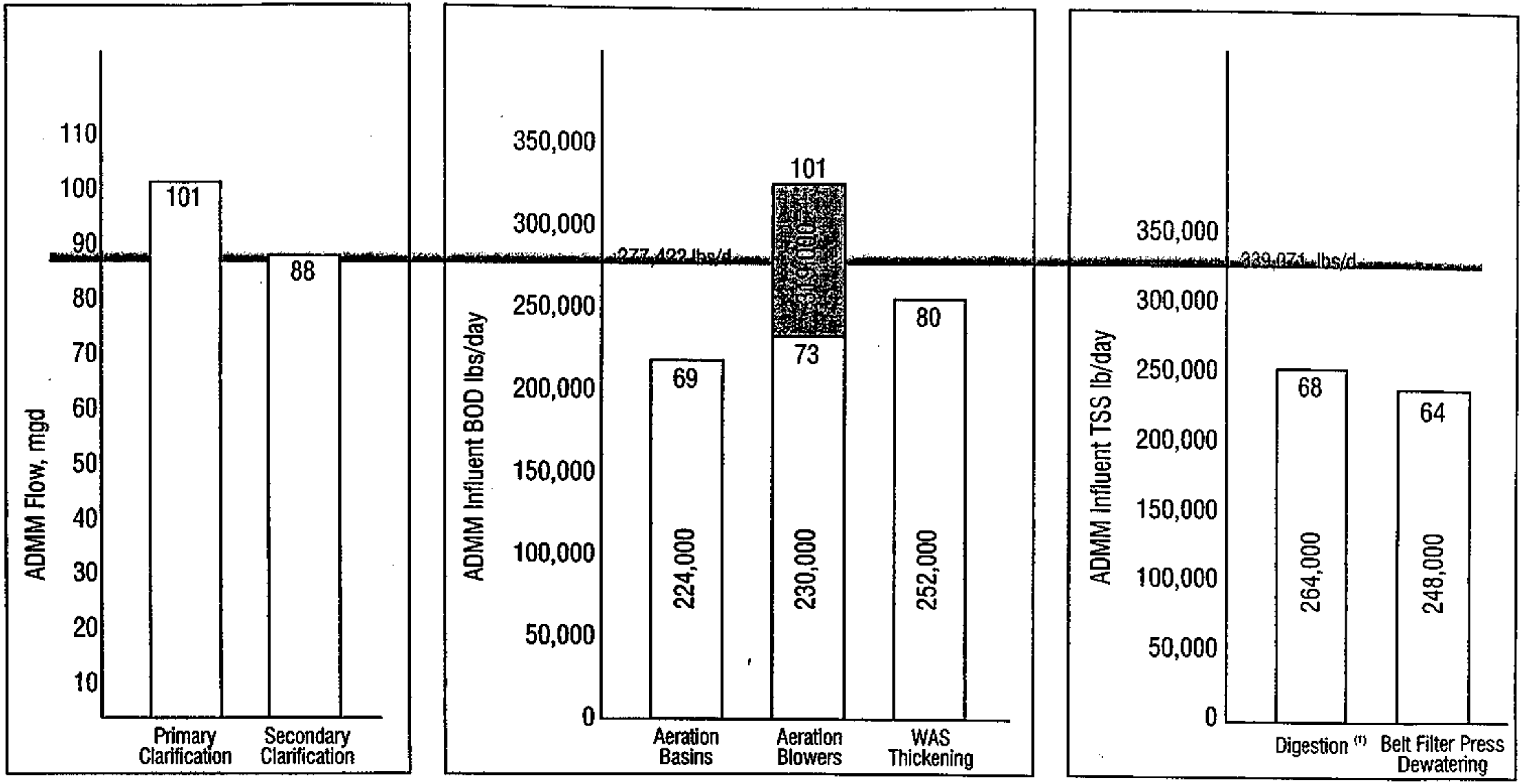


Figure 3
1998 AVERAGE DAY ANNUAL CAPACITY BASED ON ORIGINAL DESIGN CRITERIA
Fresno-Clovis Wastewater Facilities
Master Plan Report



Design Flow = 88 mgd (after completion of Phase 1b Expansion)

Reliable Capacity (standby units out of service, where indicated)

Standby Capacity

(1) Capacity not counting volume of 1 blending digester

Figure 4
1998 AVERAGE DAY MAXIMUM MONTH CAPACITY BASED ON ORIGINAL DESIGN CRITERIA
Fresno-Clovis Wastewater Facilities
Master Plan Report

FR796G3 .CDR 7/19/96

CONVENTIONAL SECONDARY TREATMENT

Additional conventional secondary treatment facilities are required for all future treatment scenarios and expansions. This section describes existing secondary treatment facilities and recommends future facility type, size and number of process units. A sensitivity analysis will be presented for each unit process to identify how changes to flow/load projections and process parameters may impact future facility planning. Additionally, the effect of implementing an 8 mgd and a 32 mgd satellite plant will be evaluated.

All future facilities requirements will be considered in addition to the facilities to be existing after the completion of the planned expansion to 80 mgd. The existing and planned facilities for the Phase 1B expansion at Plant 1 are shown in Figure 5. For reasons noted above, Plant 2 capacity was not considered relative to planning beyond the year 2000.

Headworks/Preliminary Treatment

New headworks and preliminary treatment facilities were constructed for the expansion to 68 mgd. The old headworks for Plant 1 will be abandoned.

Description/Capacity of Existing Facilities

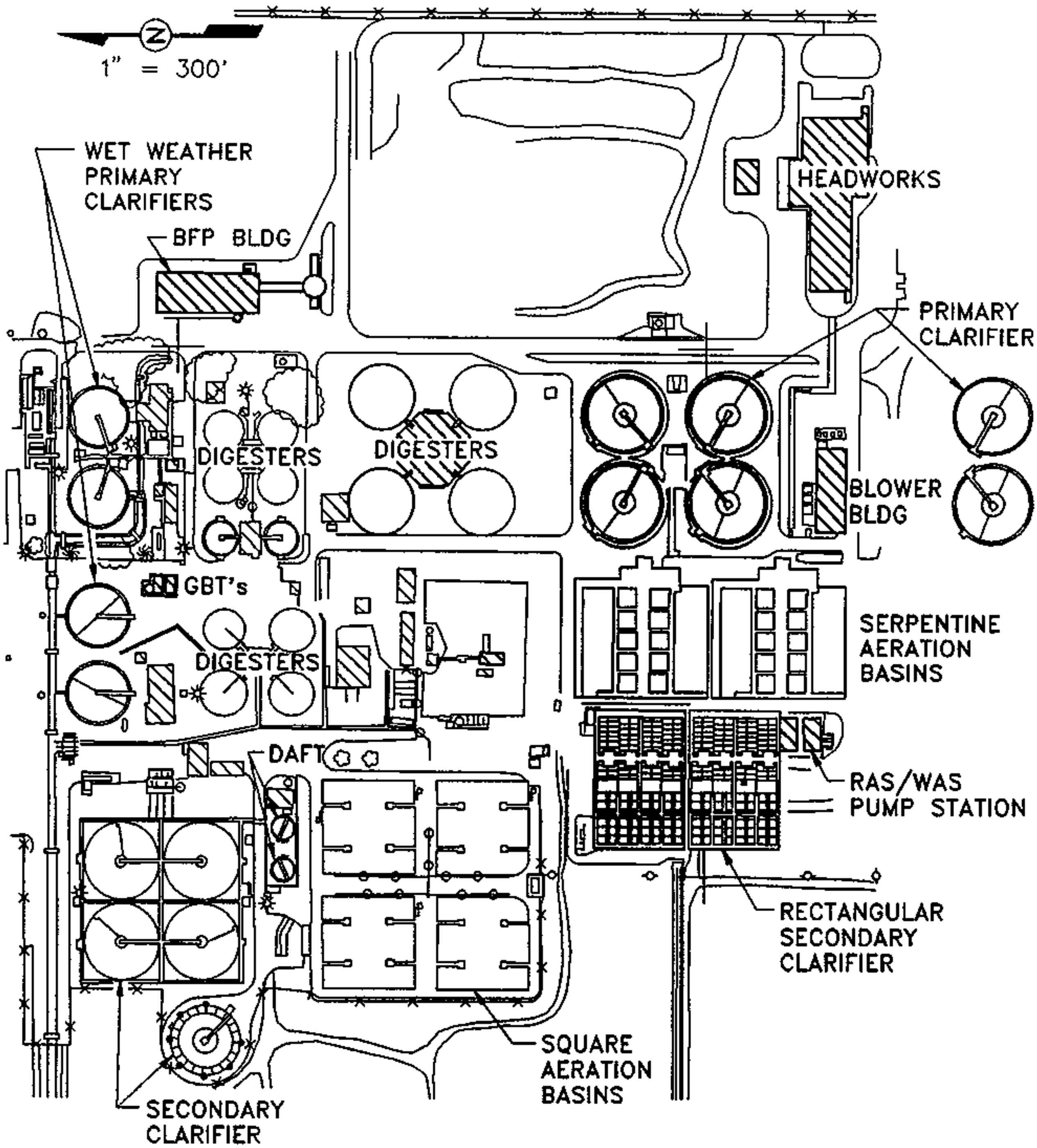
The new headworks/preliminary treatment facilities consist of six influent pumps, four mechanical bar screens with conveyors and compactors, four vortex grit basins, two parshall flumes, and chemical addition facilities. The influent pumps have a combined capacity of 203 mgd during wet weather flow with one large pump out of service. The bar screens have a combined capacity of 180 mgd with one screen out of service, the four vortex grit basins have capacity of 210 mgd with one basin out of service, and the two Parshall flumes have a combined capacity of 220 mgd. The headworks distribution structure is set up for two sets of primary clarifiers for a total of eight clarifiers, and connection to the old clarifiers for use as wet weather flow equalization with a maximum equalization flow of 101 mgd.

The headworks was designed to accommodate expansion to eight influent pumps for a firm capacity of 295 mgd, six barscreens for 300 mgd firm capacity, six grit basins for 350 firm capacity, and 3 parshall flumes for 330 mgd capacity. Expansion of the headworks will allow for three sets of primary clarifiers for a total of twelve clarifiers.

The new headworks is also provided with sodium hypochlorite systems for odor control and storage facilities for ferric chloride for use as a coagulant in the primary clarifiers.

Future Facilities Requirements

The headworks will need to be expanded to accommodate the projected increased flow and distribution to three sets of primary clarifiers.



LEGEND - 1996

EXISTING FACILITIES

NEW FACILITIES (PHASE 1A)

NEW FACILITIES (PHASE 1B)

Figure 5
EXISTING TREATMENT FACILITIES AFTER PHASE 1A AND 1B EXPANSION
Fresno - Clovis Wastewater Facility
Master Plan Report

Sensitivity Analysis

The need for expansion of the headworks is driven by projected flow during wet weather events. Changes in influent flow due to different projections or implementation of a satellite plant can change the needs for expanding the headworks. Also, changes to the wet weather peaking factor (2.0 x ADWF) can affect the need for headworks expansion. If actual flows to the RWRF match the projected population times per capita flows, or if higher PHWWF peaking factors are actualized, the headworks will need pump upgrades as well as the discussed expansion. Implementation of either an 8 mgd or a 32 mgd satellite plant will not effect the headworks expansion as the modifications will still be needed for treatment of flows to the RWRF.

Primary Treatment

Six 140 foot diameter primary clarifiers are being built for the Phase 1A and 1B expansions. These new clarifiers replace the older 115 ft diameter clarifiers which will remain as standby units for use for wet weather flow equalization and treatment.

Description/Capacity of Existing Facilities

The new primary clarifiers were designed for an average annual capacity of 15.5 mgd each based on an overflow rate of 1,010 gpd/sf. Each unit has a maximum month capacity of 16.9 mgd based on a maximum design overflow rate of 1,100 gpd/sf. Total capacity for all six existing primary clarifiers is 101 mgd during ADMMF and 93 mgd during ADAF. Recommended standby criteria is one out of every six clarifiers on standby during ADWF for routine maintenance. With the recommended standby units out of service, the reliable capacity during ADWF is 77.7 mgd.

Primary sludge is thickened in the primary clarifiers thereby eliminating the need for primary thickening facilities. One primary pump station is dedicated for each group of four clarifiers. Each clarifier has two dedicated sludge pumps and one standby pump. The primary sludge is pumped directly to the digesters were it is blended with the secondary sludge. The primary clarifiers were designed for 60 percent TSS removal and 30 percent BOD removal without any chemical addition.

Future Facilities Requirements

Planning for future primary clarifiers assumes the above mentioned design overflow rates and removal rates as well as the recommended standby criteria. Six additional primary clarifiers will be needed by the year 2020. This is also the maximum number of clarifiers that can be serviced by the expanded headworks. An additional primary sludge pump station will also be required following the original design criteria of one pump station for every four clarifiers.

Sensitivity Analysis

The need for primary clarifiers is driven by the anticipated flow and the selected design overflow rate. Variation of process operating parameters (i.e., percent removal of BOD5 and TSS) does not affect the number of primary clarifiers needed. However, a different flow projection may change the number of primary clarifiers required.

If actual flows to the RWRF matched the projections calculated by projected population times total per capita flow, rather than the trend-based projection values used for master planning, flow to the basin would be higher than anticipated. This higher projected flow coupled with the selected design and standby criteria would require planning for an additional clarifier by the year 2020. However, since the headworks is limited to distribution to only three sets of four clarifiers, the selected overflow rates would have to be modified to eliminate the need for the additional clarifier. The higher overflow rates required by a higher projected flow would not significantly change the operation or efficiency of the primary treatment system.

Implementation of a satellite plant would reduce the flow to the RWRF, thus reducing future needs of flow based treatment facilities. Implementation of an 8 mgd satellite plant does not decrease flows to the RWRF sufficiently to change the number of future primary clarifiers needed. However, a 32 mgd satellite plant would reduce flows to the RWRF changing the number of required primary clarifiers to ten by the year 2020.

Secondary/Biological Treatment - Aeration Basins and Support Facilities

Secondary treatment at the RWRF (Plant 1) is an Activated Sludge process consisting of aeration basins, aeration blowers, secondary clarifiers, and pump stations for Recycle Activated Sludge (RAS) and Waste Activated Sludge (WAS). Secondary clarifiers are discussed in the following section.

Description/Capacity of Existing Facilities - Aeration Basins

The existing aeration system consists of four square aeration basins, a RAS/WAS pump station, and a blower building to house aeration facilities. The Phase 1A and 1B expansions included four serpentine aeration basins, a RAS/WAS pump station, and a blower building.

Based on original design criteria, the capacity of the four square and four serpentine aeration basins in 1998 (anticipated completion of Phase 1B Expansion) based on aeration basin loading is 165,005 ppd BOD_5 during ADMML, 150,781 ppd BOD_5 during ADA and 131,650 ppd BOD_5 during ADW with one square basin out of service.

Air is supplied to the four square aeration basins by three multi-staged centrifugal blowers with capacity of 18,400 scfm/blower. The four existing serpentine aeration basins are provided air by four single staged centrifugal blowers with capacity of 27,000 scfm/blower. As shown in Figure 3, the blower capacity is more than adequate at this time.

Future Facilities Requirements

All new aeration basins recommended for future expansion will follow the size and design criteria used in the Phase 1A and 1B Expansions. Sixteen additional serpentine aeration basins will be required for the year 2020 based on design criteria.

Four additional RAS/WAS pump stations will be required by the year 2020 to keep the ratio of one RAS/WAS pump station per four aeration basins. Four additional blower buildings will be required by the year 2020 each with three to four 27,000 scfm blowers to maintain the ratio of one blower building per every four aeration basins.

Sensitivity Analysis - Aeration Basins

Aeration basin capacity is a function of influent loading, primary clarifier removal rates and basin design criteria. Aeration basins are a load-based unit process, so changes in load projections will impact future facility needs. It is unlikely that influent flow, BOD and TSS loadings will continue to increase at the same high rate as occurred in the last five years. However, the effect of a continued increase in loads was analyzed to identify the potential changes for future expansion of aeration basin capacity. Likewise, the effect of increased loads was compared to the effect of increased flow to identify the potential imbalance between load-based aeration basins and flow-based secondary clarifiers.

Several possible solutions are available for dealing with the problem of increasing concentrations: 1) Build more aeration basins, 2) Enhance primary removal rates with chemical addition, 3) Increase the volumetric loading rate to the aeration basins, and 4) Implement upstream source control to lower influent concentrations.

In the past the RWRF has used several of these measures to deal with increasing concentrations as well as flow through the plant. Ferric chloride and coagulant aid polymer were added to the old primary clarifiers to increase removal rates across the clarifiers. A liquid oxygen (LOX) system was added to enhance performance and reliability in the square aeration basins resulting in meeting effluent criteria while allowing higher volumetric loading on the basins. It is not the intent of the Master Plan to recommend long term application of transitional procedures such as chemical addition to the primary clarifiers and implementation of LOX systems, however it is important to note that such measure provide sufficient short term treatment to deal with unexpected increases in concentrations.

The new primary clarifiers were designed for 30 percent BOD_5 removal and 60 percent TSS removal without chemical addition based on influent concentrations of 240 milligrams per liter (mg/L) during ADAF and 290 mg/L ADMMF. Current and projected concentrations are shown in Table 3. The new primary clarifiers and headworks provide for potential chemical addition. Ferric chloride can be added at the headworks upstream of all the clarifiers and polymer can be added at the split for individual clarifiers. The addition of ferric chloride or polymer to the primary clarifiers could enhance the removal efficiencies of BOD and TSS across the clarifiers as well as increase primary sludge production. Increased removal efficiency in the primary clarifiers decreases loading to the Aeration Basins and decreases the amount of secondary solids production or waste activated sludge (WAS). Consequently, the number of Aeration Basins and WAS thickening facilities needed decreases.

The number of aeration basins chosen for master planning to the year 2020 is a result of the sensitivity analysis described below.

Using design criteria for primary removal rates and for aeration basin volumetric loading rates, the projected number of future facilities for ADMML in the year 2020 is 16 additional basins. Increased primary removal rates resulting from chemical addition decrease the number of future facilities needed to 12 basins during ADMML. Variation of the volumetric loading rates in aeration basins to 68 ppd BOD_5/1000 cf during ADMM changes the number of basins need in the year 2020 to 12 using design primary clarifier removal rates. If the population times per capita projection method is used instead of the trend-based projection, the future facilities requirements drops to 12 basins for ADMML in 2020. Implementation of a satellite plant decreases the need for additional aeration basins in 2020 to 11 for a 32 mgd satellite plant and to 15 for an 8 mgd satellite plant.

The variations in the future facility needs for aeration basins, as discussed above, are shown in Table 5. The master plan value of 16 additional basins is also shown in the table. The decision to plan for 16 additional basins relies on using the conservative trend projection and master planning design criteria.

Compatibility of Advanced Treatment with Existing Facilities

The new serpentine aeration basins have the ability to be converted for biological nutrient removal (BNR). Converting the basins for BNR would essentially derate the basins by 20 to 40 percent depending on the level of nutrient removal required. The effect of an increased level of treatment to include BNR on future facilities requirements will be discussed further in the Tertiary Treatment section.

Secondary Clarification

Secondary clarifiers are part of the secondary treatment system, providing final clarification before effluent is discharged to disposal ponds.

Table 5 Sensitivity Analysis for Aeration Basins Fresno-Clovis Wastewater Reclamation Master Plan				
Process or Operational Parameter	Original Value	Sensitivity Value	Aeration Basins Required for 2020[1]	
			ADMML	ADW[2]
Design Criteria, Volumetric Loading (VLR) ppd BOD_5/1000 cf	53 ADW 58 ADMM	-	16	10/13
Primary BOD_5 Removal, % (Coagulant Addition)	30%	40%	12	7/9
Volumetric Loading (VLR) ppd BOD_5/1000 cf	53 ADW 58 ADMM	58 ADW 68 ADMM	12	9/12
Influent BOD_5 load, 1000 ppd (Per Capita x Population Projection)	443 ADW 638 ADMM	372 ADW 536 ADMM	12	7/9
Influent BOD_5 Load, 1000 ppd (Flow Diverted to 32 mgd Satellite Plant)	443 ADW	356 ADW 514 ADMM	11	6/8
Influent BOD_5 load, 1000 ppd (Flow Diverted to 8 mgd Satellite Plant)	443 ADW	420 ADW 609 ADMM	15	9/12
Master Plan Value	-	-	16	13

(1) Number of additional aeration basins required beyond Phase 1B Expansion, ADMML/ADWL = 1.44.
(2) Number of additional aeration basins required to treat projected load without/with facilities needed for standby.

Description/Capacity of Existing Facilities

The existing secondary clarification system consists of four square/round secondary clarifiers, and one circular clarifier. An additional eight rectangular clarifiers are being constructed during the Phase 1A and 1B Expansions.

The design capacity of all the secondary clarifiers through the completion of the expansion to 80 mgd, is 88 mgd during ADMMF, 81.7 mgd during ADAF and 67.5 mgd during ADWF with one square clarifier and one rectangular clarifier out of service following the suggested standby criteria of one out of every six clarifiers out of service.

Future Facilities Requirements

Although secondary clarifiers are usually considered part of the secondary (or activated sludge) process, unlike the aeration basins which are load dependent, the secondary clarifiers are designed based on flow. Consequently, the requirements for future secondary clarifiers is less than the requirements for aeration basins due to the increasing load phenomena. However, for reliability reasons, the original design ratio of two clarifiers for every basin will continue for future design of secondary facilities. Therefore, thirty-two additional secondary clarifiers will be planned for the year 2020 corresponding with the required sixteen additional aeration basins.

Sensitivity Analysis

Variation in the number of secondary clarifiers required is driven by the number of aeration basins required. Therefore, refer to Table 5 for potential variation in secondary clarifier requirement using the ratio of 2:1 clarifiers to basins.

WAS Thickening

The waste activated sludge (WAS) is thickened prior to delivery to the digesters to achieve optimum concentration for sludge stabilization and for reduction of needed digestion capacity.

Description/Capacity of Existing Facilities

Prior to completion of the Phase 1A Expansion, all WAS thickening was performed by two 40 ft diameter Dissolved Air Flotation Thickeners (DAFTs). The historical operation of the DAFTs was a maximum of 1.15 mgd WAS flow with any additional WAS flows recycled back to the headworks. Two temporary Gravity Belt Thickeners (GBTs) have been added to mitigate the overloading of the DAFTs.

Using the design criteria for conservative GBT operation of 200 gpm/meter and an assumed 24 hour operation, the capacity of the two meter GBT is 1.15 mgd. The total existing capacity of the thickening facilities (DAFTs and GBTs) is approximately 2.3 mgd WAS flow.

Future Facilities Requirements

GBTs generally achieve higher thickened WAS concentrations and require less space than DAFTs. Therefore, all future sludge thickening facilities will be performed by two meter width GBTs.

Based on the projected ADMML and the given design criteria, an additional seven GBTs are required for the year 2020. Using standby requirements of approximately one out of every four GBTs out of service during ADAL, two units will be on standby in 2020.

Sensitivity Analysis

Capacity of sludge thickening units is a function of design criteria and solids loading. Solids to the thickening units may vary depending on influent characteristics or operation of upstream units. The master plan recommendation of seven additional units for the year 2020 is based on using design criteria. Future facilities needs for thickening is calculated for ADA conditions with standby criteria and for ADMML with all thickening units in service.

Chemical addition to the primary clarifiers results in greater solids removal in the primary system, leaving less secondary solids to be thickened. Only five additional GBTs are needed for the year 2020 during ADMML conditions with chemical addition. Variation of the aeration basin sludge yield between 0.8 to 1.0 causes a variation in GBT requirements from 6 to 8 units during ADMML. Typical sludge yields fall within this range of 0.8 to 1.0 lbs solids produced per lb BOD removed. Changes in percent solids of the WAS into thickening units also affects GBT capacity and future facilities needs. Variation of WAS percent solids from 0.5 to 1.0 percent results in variation of number of GBTs needed for ADMML between 12 and 4. The historical average WAS percent solids of 0.74 percent was used for the master plan value. Based on the wide variation of required units depending on process parameters, the chosen master plan value of seven units (without standby) falls approximately in the middle of the range.

Changes in the projected influent loading also changes the number of required future facilities. If the influent loading follow the population times per capita projection rather than the trend-based projection used, the number of needed GBTs for the year 2020 drops to five units for ADMML conditions. Implementation of a satellite plant would also lower the influent loading and change the number of needed GBTs. Operation of an 8 or a 32 mgd satellite plant changes GBT requirements in 2020 to 5 and 7, respectively. For master planning purposes, no satellite plant is assumed and the more conservative trend-based projection will be used for all future facilities planning.

The variations in GBT requirements due to changes in operation of upstream units and changes in influent loading are presented in Table 6.

Sludge Digestion

Thickened sludge from the primary clarifiers and WAS thickeners (DAFTs and GBTs) is sent to anaerobic digesters for stabilization and volatile solids reduction.

Description/Capacity of Existing Facilities

The RWRF will have a total of 12 anaerobic digesters after the completion of the Phase 1B Expansion. Digesters 1 and 2 are 75 foot diameter, 28 ft sidewater depth (swd) digesters that

Table 6 Sensitivity Analysis for GBTs Fresno-Clovis Wastewater Reclamation Master Plan				
Changed Process or Operational Parameter	Original Value	Sensitivity Value	# of GBTs Required for 2020[1]	
			ADMML	ADAL[2]
Master Plan Value[3]	-	-	7	5/7
Primary TSS Removal, % (Coagulant Addition)	60%	70%	5	3/5
Aeration Basin Sludge Yield	0.9	0.8	6	4/6
Aeration Basin Sludge Yield	0.9	1.0	8	6/8
WAS % Solids	0.74%	0.5%	12	9/12
WAS % Solids	0.74%	1.0%	4	3/5
Influent TSS load, 1000 ppd (Total Per Capita x Population Projection)	659 ADA 873 ADMM	458 ADA 606 ADMM	5	3/5
Influent TSS Load, 1000 ppd, (Flow Diverted to 32 mgd Satellite Plant)	659 ADA 873 ADMM	409 ADA 514 ADMM	5	3/5
Influent TSS Load, 1000 ppd, (Flow Directed to 8 mgd Satellite Plant)	659 ADA 873 ADMM	484 ADA 609 ADMM	7	4/6

(1) Number required beyond facilities provide through the Phase 1B Expansion.
(2) Number required to treat projected without/with facilities needed for standby.
(3) Based on design criteria.

are recommended for use as blending digesters. Digesters 3, 4 and 5 are 75 foot diameter with 26 ft swd and Digesters 6, 7 and 8 are 85 foot diameter with 27 ft swd. Digesters 9 through 12 are 105 foot diameter with 29 ft swd and were added in the Phase 1A and 1B Expansions.

Digester capacity is a function of volume needed to meet designated hydraulic residence times (HRT), and volumetric volatile solids loading. A fifteen day HRT at 95 degrees Fahrenheit is required to meet pathogen inactivation requirements for reuse and disposal of the solids by EPA Part 503 40 CFR. The existing digesters, prior to construction of Digesters 9 through 12, have not consistently met the 15 day HRT requirement or the temperature requirement, due to solids overloading, lack of capacity and insufficient heating. The temperature requirement will be met after rehabilitation of the existing digesters is complete. Sufficient capacity to meet 15 day HRT while maintaining solids loading criteria has been incorporated into design criteria for all new digesters.

The digester capacity was calculated for the total volume of digesters minus the volume of one blending digester. The volume of Digesters 2 through 12 is 932,374 cubic feet not counting cone volume. Based on this available volume and a volatile solids digester loading criteria of 0.12 lbs VS/df/day, the capacity during ADMM is limited to 231,885 lb vs/day digester feed. The capacity while meeting standby requirements of one largest digester out of service during ADA conditions, is 201,752 ppd VS.

Future Facilities Requirements

Future facilities planning for digesters includes sufficient capacity to maintain the volatile solids loading rate of 0.12 lb VS/sf/day and a 15 day HRT in year round conditions. Capacity was evaluated for projected ADMML with all units in service, except one blending digester, and for projected ADAL with one out of every ten digesters out of service for regular maintenance. Due to the digestion volume needed for the year 2020, all future digesters will be 110 ft diameter and 40 ft. sidewater depth. This larger size provides a larger volume per footprint area, thereby reducing the number of digesters needed for the future and saving land requirements.

Ten additional 110 ft diameter, 40 swd digesters will be needed by the year 2020.

Sensitivity Analysis

The number of future digesters required is a function of solids loading and digester design criteria. Solids loading to the digesters is dependent on influent characteristics and upstream process parameters and operational variations. Using volatile solids loading criteria of 0.12 lb VS/sf/day, eleven additional 110 ft. diameter, 40 ft swd. digesters are needed for the year 2020.

Chemical addition to the primary clarifiers increases the needed number of digesters during ADMM to twelve for the year 2020. Changes in the aeration basin sludge yield can also change the projected number of digesters needed. A variation of aeration basin sludge yield from 0.8 to 1.0 results in a variation between 11 and 12 of the number of digesters needed during ADMM. Historical operation of the existing aeration basins and anticipated operation of future basins result in sludge yields within the range between 0.8 and 1.0 lbs solids produced per lb of BOD_5 removed.

EPA requirements of significant pathogen reduction processes offer a range of detention times and temperature requirements. A HRT of fifteen days is the minimum detention time and requires temperature between 35°C to 55°C. If a HRT of 20 days is used rather than 15 days the temperature requirement decreases, however the number of required digesters increases to 15 for ADMML in the year 2020. There is no significant benefit to a 20 day HRT besides the factor of safety provided for meeting 503 regulations.

Additional digester requirements are based on using 110 ft diameter and 40 ft swd facilities. However, if future digesters were sized to match the 105 ft diameter, 29 ft swd digesters installed for the Phase 1A and 1B Expansions, the number of facilities required would increase to 17 digesters for ADMML in the year 2020.

Changes in influent solids loading also affects future digester requirements. If the influent solids loading followed the population times per capita projection instead of the trend-based projection, the number of digesters required decreases to 7 for meeting ADMML in 2020. Implementation of an 8 or 32 mgd satellite plant would change the digester requirements for 2020 to 8 and 11, respectively.

The affect of changing the process parameters, design criteria and influent loading, as discussed above, are shown in Table 7. Given that the master plan is using the conservative trend-based projections, the larger sized digesters, and a 15 day HRT, most of the variation in digester requirements during ADMM is eliminated. The master plan value of 10 additional digesters, shown in Table 7, was determined by design criteria for ADAL with standby. The master plan value of ten additional digesters is a conservative estimate for future facilities needs.

Solids Dewatering

Two temporary belt filter presses (BFPs) have been in operation at the RWRF for dewatering solids since August of 1994. Upon the completion of the 68 mgd expansion project, there will be seven belt filter presses, with one out of seven reserved for standby. Prior to use of the BFPs, all sludge produced at the RWRF was solar dried and stockpiled. Currently the dewatered sludge from the BFPs is hauled off site for composting.

Description/Capacity of Existing Facilities

Existing capacity of the seven BFPs was calculated using the ADA design criteria of 75 gpm/meter or 150 gpm/press. The BFPs will be operated two shifts a day (16 hours/day). The total capacity for all seven BFPs is 1.01 mgd of digested sludge, but the reliable capacity with one press out of service is 0.86 mgd. Operation of the BFPs at 150 gpm/press is anticipated to yield a cake percent solids of 18 percent or higher. This cake solids is higher than the 16 percent currently achieved due to the historical overloading of the existing two BFPs. However, once all seven presses are operational a 18 percent cake solids is expected.

Table 7 Sensitivity Analysis for Digesters Fresno-Clovis Wastewater Reclamation Master Plan				
Changed Process or Operational Parameter	Original Value	Sensitivity Value	# of Digester Required for 2020[1]	
			ADMML	ADAL[2]
Design Criteria	--	--	11	8/10
Primary TSS Removal, % (Coagulant Addition)	60%	70%	12	8/10
Aeration Basin Sludge Yield	0.9	0.8	11	7/9
Aeration Basin Sludge Yield	0.9	1.0	12	8/10
Hydraulic Retention Time, days	15	20	15	10/12
Size of Digesters	110 ft dia. 40 ft swd.	105 ft dia. 29 ft swd.	17	11/13
Influent TSS load, 1000 ppd (Total Per Capita x Population Projection)	659 ADA 873 ADMM	458 ADA 606 ADMM	7	4/5
Influent TSS Load, 1,000 ppd (Flow Diverted to 32 mgd Satellite Plant)	659 ADA 873 ADMM	529 ADA 703 ADMM	8	5/6
Influent TSS Load, 1,000 ppd (Flow Diverted to 8 mgd Satellite Plant)	659 ADA 873 ADMM	627 ADA 833 ADMM	11	7/9
Master Plan Value	-	-	10	8/10

(1) Number of additional digesters required beyond Phase 1B Expansion.
(2) Number of additional digesters required to treat projected load without/with facilities needed for standby.

Future Facilities Requirements

For future facilities needs, the BFPs will assumed to be operated for 16 hours a day, at a rate of 150 gpm/press with one out of every seven BFPs out of service during ADAL and all units in service during ADMML. Seventeen additional BFPs are required to treat the projected ADMM digested sludge flow for the year 2020.

Sensitivity/Alternatives Analysis

The number of BFPs required to dewater solids is a function of belt press loading rates and upstream process parameters or operational variations that may affect the quantity of solids produced. Using original design criteria for all upstream unit processes, an additional seventeen BFPs will be needed by the year 2020 to treat the ADMM loading without standby units.

Changes in the aeration basin sludge yield can affect the projected number of BFPs needed. A variation of aeration basin sludge yield from 0.8 to 1.0 results in a variation between 11 and 13 of the number of BFPs needed for 2020.

Variation of influent loading also changes future BFP requirement. If future influent loads follow the population time per capita projection instead of the trend-based projections, the number of BFPs needed in the year 2020 drops to ten. Implementation of either an 8 or 32 mgd satellite plant would decrease influent loading to the RWRF and change BFD requirement for 2020 to 12 and 15, respectively. For master planning purposes the more conservative projection method and an assumption of no satellite plants is used to determine future facilities requirements.

Operation of the BFPs 24 hours a day would decrease the future number of BFPs needed to 12 for ADMML in 2020 without standby. However, continuous operation without standby is not recommended even during ADMML. A 16 hour operation provides reliability and down time for maintenance. Operators at the RWRF have expressed preference to operate only two shifts a day (16 hours).

The sensitivity analysis discussed above is presented in Table 8.

TERTIARY TREATMENT

The preceding evaluation of secondary treatment identifies the future facility upgrades required to treat projected flows and loads in compliance with existing effluent discharge requirements, or the "base case" level of treatment. It is possible, however, that future regulatory changes and/or reuse and disposal requirements will necessitate an additional level of treatment (i.e., tertiary treatment). The levels of treatment which have been identified as most probable for the planning period through 2020 are:

Scenario 1: Conventional secondary treatment.

Scenario 2: Disinfection and filtration.

Scenario 3: Biological Nutrient Removal (BNR).

Scenario 4: Reverse osmosis (RO).

Table 8 Sensitivity Analysis for BFPs Fresno-Clovis Wastewater Reclamation Master Plan				
Process or Operational Parameter	Original Value	Sensitivity Value	BFPs Required for 2020 during ADAL[1]	
			ADMML	ADAL[2]
Master Plan Value[2]	-	-	17	11/14
Aeration Basin Sludge Yield	0.9	0.8	15	10/12
Aeration Basin Sludge Yield	0.9	1.0	17	12/15
Influent TSS load, 1000 ppd (Total Per Capita x Population Projection)	659 ADA 873 ADMM	458 ADA 606 ADMM	10	6/8
Influent TSS Load, 1000 ppd (Flow Diverted to 32 mgd Satellite Plant)	659 ADA 873 ADMM	529 ADA 703 ADMM	12	7/9
Influent TSS Load, 1000 ppd (Flow Diverted to 8 mgd Satellite Plant)	659 ADA 873 ADMM	627 ADA 833 ADMM	15	10/12
Operation Time, hrs	16	24	12	5/9

(1) Number of additional BFPs required beyond Phase 1B Expansion.
(2) Number of additional BFPs required to treat projected load without/with facilities needed for standby.

This section identifies future facility needs for tertiary treatment for the three scenarios above in the year 2020. Design criteria for the tertiary treatment processes are presented in Table 9.

Disinfection

Disinfection facilities are required by Scenario 2 for increased reuse potential. Based on an evaluation of disinfection alternatives, future disinfection facilities will use sodium hypochlorite (ref Task 600 TM No. 1).

Future Facilities Requirements

Chlorination facilities are commonly designed for contact times varying from 30 minutes to two hours. There are two options for design of disinfection contact facilities, coliform limits of either 23 MPN or 2.2 MPN, depending on the specific reuse criteria. Reduction of total fecal coliform to 2.2 MPN would most likely require the addition of filtration prior to disinfection. For the master planning purposes, the design criteria will be two hours contact time. Contact basins will be

Table 9 Design and Standby Criteria for Tertiary Treatment Facilities Fresno-Clovis Wastewater Reclamation Master Plan			
Unit Process	Design Criteria	Flow Condition	Standby Criteria
Chlorine Contact Basins	2 hour contact time 15 ft depth channel width: 10-30 ft	ADWF	Sufficient capacity to handle ADWF with one basin out of service.
Filtration	Dual media filters: loading = 3.7 gpm/sf, backwash = 20 gpm/sf, backwash requirements = 15 min./24 hrs	ADMMF	One filter/bank out of service during ADMMF. Sufficient capacity to handle ADWF with approximately 1 out of every five filters out of service.
Biological Nutrient Removal (BNR)	Modification of serpentine aeration basins to include anoxic zone	ADMMF	All basins in service during ADMMF. Sufficient capacity to handle ADWF with approximately one out of every six basins out of service.
Reverse Osmosis(1)	Effluent to meet background drinking water levels (range = 44-380 mg/L, average = 185 mg/L) % recovery = 85	ADMMF	N/A
Brine Treatment	Options include evaporation, deep well injection and off-site disposal in a dedicated landfill		N/A

(1) Advanced treatment with reverse osmosis/brine treatment not likely to be required. Design and standby criteria not developed at this time.

designed for the projected 2020 ADW flow. Four contact basins will be needed for the 2020 ADWF with one out of four contact basins on standby. With a fifteen foot basin depth, the surface area required for each basin is approximately 38,000 square feet. Based on the projected flows, the four basins would be able to provide 2 hours detention time during ADMMF and a 1.3 hour contact time during PHWWF (using a 2.0 PHWWF ADWF peaking factor) with all basins in service.

Filtration

The primary purpose of filtration facilities at the RWRF is to improve disinfection efficiency, thereby increasing potential reuse alternatives. Filtration is often needed to achieve a total coliform limit of less than 2.2 MPN, the most restrictive coliform discharge limit. Due to the high volume of flow to be treated, and the larger footprint requirement, dual media filters were chosen for master planning purposes rather than using a portable design such as Dynasand filters.

Future Facilities Requirements

Filtration requirements were based on treatment of ADMMF. A total of thirty-two filters would be required to treat the ADMMF flow for the year 2020 using two banks of filters with one standby filter for each bank. Each bank will be composed of sixteen filters.

Biological Nutrient Removal

Concerns about regional groundwater quality may dictate requirements to nitrify and denitrify effluent to lower nitrate concentrations. Biological nutrient removal (BNR) entails modification of the existing aeration basins and construction of new basin for nitrate (and potentially phosphorus) removal.

Future Facilities Requirements

Modification of the serpentine aeration basins to include an anoxic zone for nutrient removal will decrease the capacity of the basins by 20 to 40 percent. The addition of nitrogen removal will require derating the existing basins by 20 percent which will require an additional four aeration basins to be constructed by 2020. Modification for both nitrogen and phosphorus removal will require derating the aeration basins by 40 percent thus requiring an additional 8 basins by 2020. The new basin requirement assumes that the existing square basins cannot be retrofitted but will remain in use for secondary treatment and the effluent will be blended with the BNR effluent. The requirement for BNR is based on treating ADMMF in the year 2020.

Reverse Osmosis

The primary drinking water supply for the Fresno area is groundwater, therefore, it is assumed that in the future effluent discharged to land may be required not only to meet the MCL requirements, but also not exceed the average groundwater quality of the area to prevent degradation of the drinking water supply. Drinking water quality testing for the City of Fresno in 1994 showed TDS concentrations in the range of 44-380 mg/L (average 185 mg/L) and EC in the range of 91-580 micromhos/cm (298 average). The maximum contamination levels (MCL) for drinking water are 500 mg/L TDS and 900 micromhos/cm EC. The current effluent TDS concentrations are in the mid 400 mg/L range (not exceeding 500 mg/L), while the effluent EC ranged in 1995 from 700 to 820 mcmhos/cm.

Reverse osmosis would be required to reduce the TDS and EC levels down to current drinking water levels.

Typical high pressure reverse osmosis processes are commonly used for salt water desalination. For relatively low TDS levels, as found in the RWRF effluent, either low pressure membranes or nanofiltration should be used. Table 10 shows the design characteristics of the different types of membrane processes.

Table 10 General Reverse Osmosis System Categories (1)
Fresno-Clovis Wastewater Master Plan

System	Transmembrane pressure operating range, psi	Salinity TDS range, mg/L	Recovery Rates, %
Seawater	800-1,500	10,000-50,000	15-55
Standard pressure	400-650	3,500-10,000	50-85
Low-pressure	200-300	500-3,500	50-85
Nanofiltration	45-150	up to 500	75-90

(1) From American Water Works Association, "Water Quality and Treatment, 4th edition."

Treatment by nanofiltration assuming a 85 percent recovery rate will be used for planning purposes. Using this design criteria for ADMMF, at least fifty percent of the effluent would need to be treated to achieve approximately 290 mg/L final effluent concentration (assuming a 500 mg/L influent concentration). Approximately eighty percent of the flow would have to be treated to achieve a final effluent lower than the 1994 average drinking water concentration of 185 mg/L.

Future Facilities Requirements

Use of reverse osmosis or membrane technology also requires a large number of pretreatment facilities to prevent membrane fouling, and brine treatment for disposal of the recovered salts. Typical pretreatment facilities include chemical addition facilities with rapid mix basins, flocculation basins and sedimentation basins. Additionally filtration is usually required prior to membrane application. Clearly, additional treatment is very costly -- both in capital and operations and maintenance costs. The costs of adding RO for land disposal are not favorable compared to other treatment/disposal alternatives e.g., discharge to river. Additionally, it is not prudent to treat for EC/TDS at the plant in lieu of reducing load at source through pretreatment programs.

EFFLUENT REUSE/DISPOSAL AND DISTRIBUTION FACILITIES

The effluent distribution and disposal facilities will require expansion and modification to accommodate increasing flows and changing reuse/disposal alternatives. The existing effluent ponds and canals are discussed in Task 600 TM 2 in relation to capacity needs for wet weather events. The existing pond capacity is also discussed in Task 700 TM 3 as an outcome of groundwater modeling. Future reuse and disposal alternatives were developed in Task 700 TM 5.

Effluent Canals

Effluent is discharged from the treatment facilities into a canal system which distributes the effluent to disposal ponds on-site. The evaluation of the existing canal system in Task 600 TM 2 shows insufficient capacity in the existing system. Canal A has peak capacity between 90 and 120 mgd. A new canal or pipe system will be required for replacement (or expansion) of Canal A, as discussed in Task 600 TM 2.

Effluent Disposal Ponds

The existing 1,414 acres of on-site effluent ponds do not have sufficient capacity to handle projected flows or current flows due to decreased percolation rates and the expanding groundwater mound under the RWRF. The effluent disposal system and groundwater considerations were evaluated in Task 700 TM 3.

Additional land has been purchased for new pond construction. These new ponds shown in Figure 1 will not increase long-term on-site capacity due to the groundwater mound constraint but the new ponds will help start a rehabilitation program for the existing ponds and provide interim capacity until off-site reuse and disposal alternatives are developed. The new ponds, expected to be complete after the summer of 1996, will increase total pond area to 1,686 acres.

Proposed future reuse and disposal is discussed in Task 700 TM 5.

Effluent Pump Station/Junction Box

It is likely that implementation of any off-site reuse or disposal alternatives will require effluent pumping or an effluent junction box for gravity flow off-site. Placement of an effluent pump station was identified in Task 600 TM 2.

ANCILLARY/SUPPORT FACILITIES

Additional land and facilities have historically been used for sludge drying and disposal and treatment and disposal of winery stillage.

Sludge Drying/Disposal Beds

Prior to mid-1994 when the belt filter presses were operational, all digested sludge was spread in solar drying beds. The dried sludge was historically stockpiled at the RWRF until a contract with San Joaquin Composting was obtained and the sludge was trucked off-site. The sludge drying beds are being converted into disposal ponds or will be built on during expansion projects. A plan for removal of the stockpiled sludge is still being evaluated. Figure 1 shows the existing RWRF layout including the sludge drying beds and storage areas. Sludge Bed No. 2 will be kept for use as a backup for the belt filter presses and for cleanout of the digesters. Piping from the digesters to Bed No. 2 is already in place.

The land immediately west of Plant 2 currently has an earth-lined oxidation ditch that is not used. It is recommended that this area be reserved for future sludge disposal/reuse pilot studies. Further details on the pilot studies and recommendations for future reuse/disposal are included in Task 900 TM 2.

Winery Stillage

Wine stillage is delivered to the RWRF through a separate sewer system. The stillage has historically been spread on a 95 acre site along the north edge of the RWRF as shown in Figure 1. RWRF staff is currently evaluating potential alternatives for the stillage operation including farming options to control nitrogen in the soil and groundwater. The preliminary plan is presented in Appendix D.

SUMMARY

The number of future facilities required by the year 2020 are summarized in Table 11.

Table 11 Summary of Future Facilities Requirements Fresno-Clovis Wastewater Reclamation Master Plan		
Treatment Facility	Size/Type	Number of Additional Facilities
Conventional Secondary Treatment		
Headworks	---	Expansion of existing headworks
Primary Clarifiers	140 ft. diameter	6
Aeration Basins	Serpentine	16
Secondary Clarifiers	Rectangular	32
Gravity Belt Thickeners	2 meter thickeners	7
Digesters	110 ft diameter, 40 ft swd	10
Belt Filter Presses	2 meter presses	17
Tertiary Treatment(1)		
Chlorine Contact Basins	38,000 sf surface area, each	4
Filtration	Dual media filters	32
Biological Nutrient Removal Basins	Serpentine	8
Effluent Reuse/Disposal and Distribution		
Distribution Canal	--	New or Modified Canal A
Disposal Ponds		As Needed

(1) Tertiary treatment facilities currently not required. Future facilities requirement based on planning for changed reuse/disposal requirements.